



2012-12

Special operations forces aviation on a shoestring budget: an effectiveness analysis of light and medium fixed wing aircraft

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THESIS

**SPECIAL OPERATIONS FORCES AVIATION ON A
SHOESTRING BUDGET: AN EFFECTIVENESS ANALYSIS
OF LIGHT AND MEDIUM FIXED WING AIRCRAFT**

by

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December 2012

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| REPORT DOCUMENTATION PAGE | | | Form Approved OMB No. 0704-0188 | |
|---|--|---|---|--|
| Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503. | | | | |
| 1. AGENCY USE ONLY (Leave blank) | | 2. REPORT DATE December 2012 | 3. REPORT TYPE AND DATES COVERED Master's Thesis | |
| 4. TITLE AND SUBTITLE Special Operations Forces Aviation on a Shoestring Budget: An Effectiveness Analysis of Light and Medium Fixed Wing Aircraft | | | 5. FUNDING NUMBERS | |
| 6. AUTHOR(S) Martin W. Weeks, III and Walter M. Winter | | | 8. PERFORMING ORGANIZATION REPORT NUMBER | |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000 | | | 10. SPONSORING/MONITORING AGENCY REPORT NUMBER | |
| 9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A | | | 11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. | |
| 12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited | | | 12b. DISTRIBUTION CODE A | |
| 13. ABSTRACT (maximum 200 words) If properly selected, low-cost commercially available off-the-shelf light- and medium-fixed-wing aircraft are sufficient to effectively accomplish special operations aviation mission sets in support of special operations ground forces. As the nature of combat continues to shift away from traditional state-on-state wars to more irregular conflicts, the skills possessed by special operations forces (SOF) will become key to a nation's success in achieving its national security aims. While numerous allied nations possess skilled and ready ground SOF components, relatively few possess special operations aviation capabilities. This lack is largely due to the prohibitively high costs of acquiring and maintaining such specialized niche aircraft. This study employs a qualitative analysis of candidate aircraft—examining acquisition costs, cost per flying hour, aircraft specifications, and scoring against a derived list of hallmark qualities of SOF aircraft to assess candidate aircraft utility. After evaluating candidate aircraft, it was determined that all four light-fixed-wing and all three medium-fixed-wing candidate aircraft are fine choices for executing SOF support. The Britten-Norman BN2T-4S Defender outscored the other candidates, possessing the most hallmark qualities. However, the Pilatus PC-6 Porter was the most economically efficient light-fixed-wing platform, costing \$2M less than the Defender over a typical aircraft lifespan. In the medium-fixed-wing category, the Alenia Aermacchi C-27J is the clear standout in overall performance and utility. More important than these aircraft recommendations, it is imperative that preference be based on which aircraft capabilities a nation values most, given its specified budget. | | | | |
| 14. SUBJECT TERMS SOF Aviation, NATO SOF, NSHQ, Light-Fixed- Wing Aviation, Medium-Fixed-Wing Aviation, Special Operations, Aviation, Multi-Mission Aircraft | | | 15. NUMBER OF PAGES 131 | |
| | | | 16. PRICE CODE | |
| 17. SECURITY CLASSIFICATION OF REPORT Unclassified | 18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified | 19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified | 20. LIMITATION OF ABSTRACT UU | |

NSN 7540-01-280-5500

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

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AN EFFECTIVENESS ANALYSIS OF LIGHT AND MEDIUM FIXED WING
AIRCRAFT**

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MASTER OF SCIENCE IN DEFENSE ANALYSIS

from the

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ABSTRACT

If properly selected, low-cost commercially available off-the-shelf light- and medium-fixed-wing aircraft are sufficient to effectively accomplish special operations aviation mission sets in support of special operations ground forces. As the nature of combat continues to shift away from traditional state-on-state wars to more irregular conflicts, the skills possessed by special operations forces (SOF) will become key to a nation's success in achieving its national security aims. While numerous allied nations possess skilled and ready ground SOF components, relatively few possess special operations aviation capabilities. This lack is largely due to the prohibitively high costs of acquiring and maintaining such specialized niche aircraft.

This study employs a qualitative analysis of candidate aircraft—examining acquisition costs, cost per flying hour, aircraft specifications, and scoring against a derived list of hallmark qualities of SOF aircraft to assess candidate aircraft utility. After evaluating candidate aircraft, it was determined that all four light-fixed-wing and all three medium-fixed-wing candidate aircraft are fine choices for executing SOF support. The Britten-Norman BN2T-4S Defender outscored the other candidates, possessing the most hallmark qualities. However, the Pilatus PC-6 Porter was the most economically efficient light-fixed-wing platform, costing \$2M less than the Defender over a typical aircraft lifespan. In the medium-fixed-wing category, the Alenia Aermacchi C-27J is the clear standout in overall performance and utility. More important than these aircraft recommendations, it is imperative that preference be based on which aircraft capabilities a nation values most, given its specified budget.

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LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|--------|---|
| ACC | Air Combat Command |
| AFRL | Air Force Research Labs |
| AFSOC | Air Force Special Operations Command |
| AFSOF | Air Force Special Operations Forces |
| AMARG | Aerospace Maintenance and Regeneration Group |
| ASE | Aircraft Survivability Equipment |
| ATK | Alliant Techsystems Incorporated |
| AVPOL | Aviation, Petroleum, Oils and Lubrications |
| | |
| BDA | Battle Damage Assessment |
| | |
| C2 | Command and Control |
| CAIG | Cost Analysis Improvement Group |
| CAS | Close Air Support |
| CASA | Construcciones Aeronáuticas SA |
| CLS | Contract Logistics Support |
| COCO | Carry-On/Carry-Off |
| COIN | Counter Insurgency |
| COMINT | Communications Intelligence |
| COTS | Commercially Available Off-the-Shelf |
| CPFH | Cost Per Flying Hour |
| CPG | Comprehensive Political Guidance |
| CT | Counter Terrorism |
| | |
| DA | Direct Action |
| DoD | Department of Defense |
| DOS | Department of State |
| | |
| EADS | European Aeronautic Defence and Space Company |
| EDA | Excess Defense Article |
| ELINT | Electronic Intelligence |
| EO/IR | Electro-Optical/Infrared |
| | |
| FAA | Federal Aviation Administration |
| FARP | Forward Arming and Refueling Point |
| FID | Foreign Internal Defense |
| FITS | Fully Integrated Tactical System |
| FMS | Foreign Military Sales |
| | |
| GFC | Ground Force Commander |
| GPC | Government Purchase Card |
| GSD | General Support Division |

| | |
|----------|--|
| HAD | High Altitude Delivery |
| HHQ | Higher Headquarters |
| HLZ | Helicopter-Landing Zone |
| HMMWV | High Mobility Multipurpose Wheeled Vehicle |
| ICAO | International Civil Aviation Organization |
| IMINT | Imagery Intelligence |
| IPTN | Industri Pesawat Terbang Nusantara |
| ISR | Intelligence, Surveillance, and Reconnaissance |
| IW | Irregular Warfare |
| JCA | Joint Cargo Aircraft |
| JOC | Joint Operating Concept |
| JP | Joint Publication |
| JSOU | Joint Special Operations University |
| LAPES | Low Altitude Parachute Extraction System |
| LAAR | Light Attack/Armed Reconnaissance |
| MA | Military Assistance |
| MEDEVAC | Medical Evacuation |
| MGTOW | Max Gross Takeoff Weight |
| MSD | Material Support Division |
| NATO | North Atlantic Treaty Organization |
| NSAv | Nonstandard Aviation |
| NSCC | NATO Special Operations Coordination Centre |
| NSHQ | NATO Special Operations Headquarters |
| OSD | Office of the Secretary of Defense |
| OSS | Office of Strategic Services |
| POL | Petrol, Oils, and Lubricants |
| QDR | Quadrennial Defense Review |
| QRM | <i>Quadrennial Roles and Missions Report</i> |
| RNAV | Area Navigation |
| SATCOM | Satellite Communications |
| SFA | Security Force Assistance |
| SIGINT | Signals Intelligence |
| SO | Special Operations |
| SOF | Special Operations Forces |
| SOUTHCOM | Southern Command |

| | |
|------------|--|
| SR | Special Reconnaissance |
| STOL | Short Takeoff and Landing |
| TAC-A | Tactical Air Controller-Airborne |
| TCAS | Traffic Collision and Avoidance System |
| TTP | Tactic, Technique, and Procedure |
| U.S. | United States |
| USAF | United States Air Force |
| USCG | United States Coast Guard |
| USSOCOM | United States Special Operations Command |
| USSOUTHCOM | United States Southern Command |
| UW | Unconventional Warfare |

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ACKNOWLEDGMENTS

First and foremost, we would like to thank our families. Without your support and dedication, we could have never completed this project. We are also sincerely grateful to our advisors: Doctor Kalev Sepp and Colonel (retired) Brian Greenshields. Your advice, wisdom, and commitment to academic rigor was crucial to this project's success.

We would also like to thank all the faculty members of the Naval Postgraduate School's Department of Defense Analysis. Your insight, commitment to student success, and professionalism has made the Special Operations/Irregular Warfare curriculum an academic experience like no other. You have helped steer us through the research process and have ensured all the special operators in this academic program return to their command as better leaders, well prepared to handle the growing irregular threats of the world.

Finally, we would like to thank all those who helped in shepherding us through the NATO SOF Air Wing study that was the impetus for our thesis. Without the large amounts of time dedicated to the completion of that preliminary project, our thesis would have certainly proven much more challenging to complete. Key among you are: Naval Postgraduate School Defense Analysis faculty, Naval Postgraduate School Senior Air Force Fellow, Headquarters AFSOC/A3T Staff, Headquarters AFSOC/A5K, A5RV, and A5KJ Staffs, and NATO SOF Headquarters Staff.

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I. INTRODUCTION

*SOF effectiveness in this modern threat environment is only possible when properly enabled with appropriate dedicated or habitually-associated air capability.*¹

—Lieutenant General Frank Kisner
Commander, NATO SOF Headquarters, 2011

A. STRATEGIC CONTEXT

1. Background

Today, many states are facing a growing number of irregular or unconventional threats that dominate the attention of their political and defense institutions. These diverse threats have the potential to undermine regional or even international stability by creating a “low boil,” enduring conflict for the conceivable future. Special Operations Forces (SOF) provide a versatile mechanism that is ideally suited to combat these ambiguous and dynamic irregular threats. Furthermore, SOF allow national and collective defense establishments to retain alternative possibilities of action through employing a force that is more agile, flexible, and has a smaller footprint than their conventional counterparts. Often, these capabilities are seen as more politically acceptable to both the providing nation, and to the nation in which operations are conducted.

However, the flexibility that has become a hallmark trait of SOF has historically relied on a synergy of action between elements of air, maritime, and ground special operations, operating collaboratively under extremely non-standard conditions. Lessons learned from operational successes and failures, such as the 1980 failed rescue of American citizens from the embassy in Iran,

¹ Lieutenant General Frank Kisner, “Special Air Warfare and a Coherent Framework for NATO SOF Aviation” (Speech to XXI Seminario Internacional Cátedra Alfredo Kindelán, Madrid, Spain, November 14, 2011).

have clearly demonstrated the benefit of dedicated and habitually associated SOF air assets to support the SOF ground component.² The results of SOF organizations without habitual training relationships include mission degradation, cancelations, and overall ineffectiveness. As an official North Atlantic Treaty Organization (NATO) study notes, “Ad-hoc attachment of [air assets] and capabilities simply fails to create the habitual relationships and ‘no-fail’ proficiency required by SOF.”³

Therefore, to ensure success in SOF missions, and to hone SOF tactics, techniques, and procedures (TTPs), specially equipped air units should be established to provide needed support. These associated special air warfare units should be properly designated, equipped, and intimately familiar with SOF mission particulars and the proficiency required in TTPs that support those requirements.

A key component of effective SOF aviation is the proper selection of aircraft to perform the mission. While highly specialized niche aircraft have proven to be vital to the United States’ SOF aviation capability, it is unrealistic to assume U.S. allies can purchase the same aircraft for their use. Most nations lack the resources to procure, maintain, and employ these assets with proficiency and for the long term. However, as the NATO Special Air Warfare Manual points out, “combat experience has demonstrated that technologically sophisticated aircraft are not required for every special air warfare mission.”⁴ What is required, however, is a specially trained aviator who can effectively employ an adequately equipped aircraft in an extraordinary manner. Given these assumptions, smaller nations should perform a cost-benefit analysis to examine the relative utility of a low-cost, sufficiently-equipped SOF aircraft. The alternative to employing such a

² Examples of operational successes in which dedicated SOF air support was utilized are the 1940 German attack on Eben Emael and Israel’s raid on Entebbe in 1976.

³ NATO Special Operations Coordination Centre, *The North Atlantic Treaty Organization Special Operations Forces Study* (December 4, 2008), A1.

⁴ NATO, *Special Air Warfare Manual Version 1.0* (Shape, Belgium, 2010), 3.

capability must also be considered: the status quo of reliance on conventional airpower assets for SOF support.

2. Criteria for Employing SOF

The success of special operations depends largely on the training and professionalism of the soldiers, sailors, marines, and airmen on the objective. The SOF Truth that “Humans are more important than hardware” carries more weight than its four counterparts: Quality is better than quantity; SOF cannot be mass-produced; Competent SOF cannot be created after emergencies occur; and Most special operations require non-SOF assistance.⁵ Yet, a lack of proper equipment can force operators to take unnecessary risks in order to accomplish their tasking. In planning for a special operation, five key measures must be considered. Figure 1 presents the criteria to determine whether to employ SOF.

| FIVE SOF MISSION CRITERIA |
|--|
| 1. Must be an appropriate special operations forces (SOF) mission or activity. |
| 2. Mission or tasks should support the joint force commander's campaign or operation plan, or special activities. |
| 3. Missions or tasks must be operationally feasible, approved, and fully coordinated. |
| 4. Required resources must be available to execute and support the SOF mission. |
| 5. The expected outcome of the mission must justify the risks. |

Figure 1. Criteria for employment of SOF.⁶

⁵ U.S. Special Operations Command, *Fact Book 2012*, 48, retrieved 15 March 2012, <http://www.fas.org/irp/agency/dod/socom/factbook-2012.pdf>. Originally published in John M. Collins, *Green Berets, SEALs & Spetsnaz: U.S. and Soviet Special Military Operations* (Washington, DC: Pergamon Basseys, 1987), xiii.

⁶ U.S. Joint Chiefs of Staff, *Joint Publication 3-05: Special Operations*, II-4, retrieved 22 March 2012, <http://www.fas.org/irp/doddir/dod/jp3-05.pdf>.

As campaign planners thoroughly analyze the merit of utilizing SOF, they must also pursue ways to create efficiencies under the edict of “smart defense.”⁷ However, there is a fine line between shrewd cost-saving initiatives and cut-rate acquisitions. One is sensible, while the latter is irresponsible. In order for U.S. allies to effectively execute special operations of any type, financial resources will have to be levied to field an organic air component.

3. Definitions

a. Aircraft Weight Classifications

The category of aircraft referred to in this study as “Light-Fixed-Wing” includes platforms that weigh no more than 12,500 pounds at Max Gross Takeoff Weight (MGTOW).⁸ The Federal Aviation Administration (FAA) classifies aircraft by weight, but does not make a distinction for aircraft weighing less than 41,000 pounds. Any platform that has a MGTOW of less than 41,000 pounds is considered “small.” For reference, the other weight classes are “large” (41,000–300,000 pounds MGTOW) and “heavy” (greater than 300,000 MGTOW).⁹ Additionally, in 2007 the FAA began using a fourth category with the introduction of the Airbus Industries A-380. This “Super” aircraft is without peer at a MGTOW of 1.3 million pounds in its freighter configuration, and 1.2 million pounds in its

⁷ The term “smart defense” was coined by Lt. Gen. Frank J. Kisner in his Speech to the XXI Seminario Internacional Cátedra Alfredo Kindelán, Madrid, Spain, 14 November 2011, and has been adopted by NATO. In his speech at the 2012 NATO Summit in Chicago, NATO Secretary General Anders Fogh Rasmussen explained that “Smart Defense” is “setting clear priorities for what we should spend our defence dollars and euros on. It means specialising in what nations do best. And it means working more closely together to provide capabilities that no single nation can afford.”

⁸ This weight was chosen because aircraft weighing no more than 12,500 pounds at takeoff do not require a type rating for the pilot in command. This has the potential for a high cost savings in aircrew training, certification, and currency requirements.

⁹ U.S. Department of Transportation, “Appendix A, Aircraft Information Fixed-Wing Aircraft,” *FAA Air Traffic Organization Policy*, Order JO 7110.65U effective 9 February 2012, retrieved 25 March 2012, <http://www.faa.gov/documentLibrary/media/Notice/N7110.525.pdf>.

passenger configuration. With the A-380’s worldwide proliferation, and familiarity among pilots and air traffic controllers, the Super weight class is now unused, leaving the A-380 in the Heavy aircraft category.¹⁰

The International Civil Aviation Organization (ICAO) classifies aircraft differently from the FAA. Aircraft weighing less than 15,000 pounds at MGTOW are designated “light.” Those with MGTOW between 15,000 pounds and 300,000 pounds are “medium.” The ICAO’s weight structure for “heavy” aircraft aligns with the FAA: greater than 300,000 pounds. For the purposes of this study, ICAO guidelines are used to define “Medium-Fixed-Wing” aircraft (15,000–300,000 MGTOW). A comparison of how the two aviation oversight organizations classify aircraft is at Table 1.¹¹

| MGTOW (lbs) | FAA | ICAO |
|--------------------|---------------------------|-------------|
| < 15,000 | - | Light |
| < 41,000 | Small | Medium |
| 41,000 - 300,000 | Large | Medium |
| > 300,000 | Heavy | Heavy |
| A-380 | Super (no longer used) | - |

Table 1. Aircraft Weight Classifications

¹⁰ U.S. Department of Transportation, “Interim Procedures for A380 Proving and Promotional Flights,” *FAA Air Traffic Organization Policy*, Order JO 7110.478 effective 1 October 2007, <http://www.faa.gov/documentLibrary/media/Notice/ND/N%20JO%207110.478.pdf>.

¹¹ EuroControl, “Revising wake turbulence categories to gain capacity,” retrieved 25 March 2012, http://www.eurocontrol.int/eec/public/standard_page/EEC_News_2008_3_RECAT.html.

b. Short Takeoff and Landing (STOL)

There are two widely accepted definitions for “Short Takeoff and Landing (STOL)”:

1. The ability of an aircraft to clear a 50-foot (15 meters) obstacle within 1,500 feet (450 meters) of commencing takeoff or in landing, to stop within 1,500 feet (450 meters) after passing over a 50-foot (15 meters) obstacle.¹²
2. A STOL aircraft is an aircraft with a certified performance capability to execute approaches along a glideslope of 6 degrees or steeper and to execute missed approaches at a climb gradient sufficient to clear a 15:1 missed approach surface at sea level.¹³ A STOL runway is one [that] is specifically designated and marked for STOL aircraft operations, and designed and maintained to specified standards.¹⁴

c. Multi-mission

For the purposes of this study, the term “multi-mission aircraft” will be utilized to define platforms that possess the design, capability, and equipment to enable the execution of various air mission sets on a given sortie. While it is a commonly used term in the aviation industry, an agreed-upon definition of “multi-mission aircraft” is lacking. There are, however, several related terms that serve to shape the definition of multi-mission. The *Military Dictionary* differentiates the following often-misapplied terms:

1. Multi-role: A vehicle (primarily aircraft) that can be used for more than one purpose, such as a fighter or attack or reconnaissance aircraft.¹⁵

¹² U.S. Joint Chiefs of Staff, *Joint Publication 1–02: Department of Defense Dictionary of Military and Associated Terms*, 298, retrieved 23 March 2012, http://www.dtic.mil/doctrine/new_pubs/jp1_02.pdf.

¹³ A 15:1 climb ratio suggests that for every fifteen feet of horizontal distance on a missed approach, a STOL aircraft must be able to climb sufficiently to clear an object an additional foot in height.

¹⁴ *U.S. House of Representatives Committee of Science and Technology*, 2 (1984) (Statement of John Kern, Deputy Director of Flight Operations, Federal Aviation Administration), retrieved 10 October 2012, <http://testimony.ost.dot.gov/test/pasttest/84test/kern1.PDF>.

¹⁵ The Military Dictionary, “multi-role,” accessed 10 September 2012, <http://www.military-dictionary.org/DoD-Military-Terms/A/6/multi-role>.

2. Swing-role: The ability to employ a multi-role aircraft for multiple purposes during the same mission.¹⁶

Historically, aircraft manufacturers have used other derivatives of this terminology to market new platforms. For example, the Dassault Corporation coined the classification of “Omni-Role” as a marketing term to differentiate its Rafale aircraft from other multi-role fighters, like the Eurofighter, Lockheed Martin F-35, and the Saab JAS-39 Gripen. This differs from the widely adopted multi-role description used by rival aircraft manufacturers, largely as a result of what Dassault claims is “the aircraft’s ability to provide its pilot with data fused from onboard sensors.”¹⁷ Examples of this platform’s employment include flights conducted in 2011 over Libya in Operation UNIFIED PROTECTOR, where in a single mission the aircraft could combine air-to-air, reconnaissance, and air-to-ground utility.¹⁸ While the validity of the air-to-air threat in Libya was arguable, what is more important is the striking similarity between this definition and that of a swing-role aircraft. Another aerospace corporation, BAE, similarly promotes the notion that “an aircraft that can accomplish both air-to-air and air-to-surface roles on the same mission and swing between these roles instantly offers true flexibility. This reduces cost, increases effectiveness, and enhances interoperability with allied air forces.”¹⁹ While these definitions complement each other, there is inconsistency within the aircraft industry with respect to this terminology.

¹⁶ The Military Dictionary, “swing-role,” accessed 10 September 2012, <http://www.military-dictionary.org/DoD-Military-Terms/A/6/swing-role>.

¹⁷ Craig Hoyle, “France’s Rafale Fighter Proves its ‘Omni-Role’ Skills,” *Flightglobal International*, June 14, 2011, <http://www.flightglobal.com/news/articles/frances-rafale-fighter-proves-its-omnirole-skills-357687/>.

¹⁸ Pierre Tran, “Libya Extends Rafale’s Combat Experience,” *Defense News*, June 13, 2011, <http://www.defensenews.com/article/20110613/DEFFEAT06/106130316/Libya-Extends-Rafale-s-Combat-Experience>.

¹⁹ BAE Systems, “BAE Systems delivers Swing Role Radar capability to Eurofighter Typhoon,” retrieved from 15 August 2012, http://www.baesystems.com/Newsroom/NewsReleases/2001/press_190620012.html.

The quintessential multi-mission aircraft is one that airlifts a team to execute a direct action mission, airdrops the assaulters, provides surveillance during actions on the objective, supports with precision fires, escorts the team to an extraction point, and then airlifts it out to friendly lines. While this example might be deemed far-fetched, consider the force-multiplication of such an asset. Not only is there an outstanding business case for procuring this type of weapon system in lieu of multiple single-role platforms, but the ground force commander's perspective is also a valid concern. Having an aircraft overhead at one's disposal that can perform the tactical intelligence, surveillance, and reconnaissance (ISR) role and then provide close air support (CAS) as needed is a welcome capability, and carries immeasurable weight in terms of perceived force protection of ground personnel.

The notion of developing aircraft with more than one assigned mission is almost as old as powered flight. British manufacturers produced the first multi-role aircraft as early as 1917.²⁰ The Armstrong Whitworth FK.8 proved to be a highly versatile platform, taking on a variety of sortie types through its production run. The FK.8 was utilized for day and night bombing, ground attack/close air support, patrol, and aerial reconnaissance. Alongside the FK.8 as a pioneer in multi-role aircraft was the Airco/deHavilland DH.4, a mass-produced daytime bomber. Following World War II, the DH.4 served the roles of aerial surveyor and crop duster.²¹

²⁰ The Avro 523 Pike Short-Range Bomber was the first multi-role aircraft. The 523 was developed in response to a British Royal Flying Corps requirement for an airframe capable of scouting duties as primary with the role of bombing as secondary. Two airframes were built in 1916, but the program did not make it beyond the prototype stage.

²¹ Military Factory, "Military Multirole Aircraft," accessed 6 May 2012, <http://www.militaryfactory.com/aircraft/military-multirole-aircraft.asp>.



Figure 2. Armstrong Whitworth FK.8

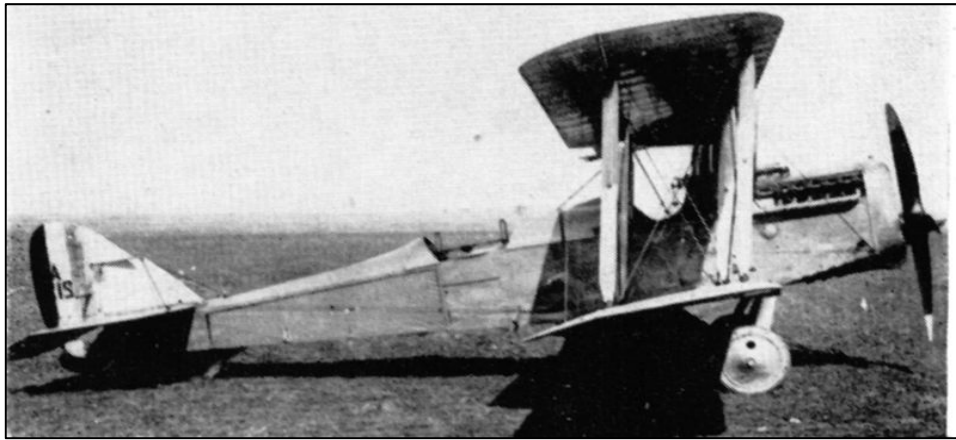


Figure 3. Airco/deHavilland DH.4

d. Commercially Available Off-the-Shelf

Commercially available off-the shelf (COTS) is defined as any item of supply (including construction material) that is:

1. A commercial item (not government produced);
2. Sold in substantial quantities in the commercial marketplace; and
3. Offered to the Government, under a contract or subcontract at any tier, without modification, in the same form in which it is sold in the commercial marketplace; and

- 4 Does not include bulk cargo, as defined in Section 3 of the Shipping Act of 1984, such as agricultural products and petroleum products.²²

The use of COTS products has been encouraged, and sometimes mandated, in many government programs in recent years. Such products traditionally offer significant savings in development, procurement, and maintenance.

e. Cost Per Flying Hour

Each branch of military service in the U.S. has a distinct process for calculating Cost Per Flying Hour (CPFH) for its weapon systems. Although service-specific, these programs are provided with oversight and approval by the Office of the Secretary of Defense.²³ A brief outline of how the U.S. Air Force calculates CPFH will set the stage. The CPFH program is standardized across the U.S. Air Force. For each aircraft, CPFH is updated every program objective memorandum cycle. There are four categories upon which CPFH is based: Material Support Division (MSD); General Support Division (GSD); Flying Hour (FH) Government Purchase Card (GPC); and Aviation, Petroleum, Oils and Lubrications (AVPOL).

MSD: Material Support Division consists of repairable items (e.g., radios, avionics, landing gear). To build the MSD factor, eight quarters (two years) of historical data and flying hours are analyzed in order to calculate a mean time between failures. This figure is used to model future consumption requirements based on projected flying hours and cost inflation.

²² Acquisitions Central, "Definitions," retrieved 4 September 2012, https://www.acquisition.gov/far/html/Subpart%202_1.html#wp1145508.

²³ U.S. Government Accountability Office, "Defense Management: DoD Needs Better Information and Guidance to More Effectively Manage and Reduce Operating and Support Costs of Major Weapon Systems," July 2010, retrieved 11 September 2012, <http://www.gao.gov/new.items/d10717.pdf>.

GSD: General Support Division consists of “expendable” bench stock items (e.g., nuts, bolts, o-rings, screws). The GSD factor is calculated in the same way as the MSD factor: two-year review, determine mean time between failures, etc.

FH GPC: Flying Hour Government Purchase Card is used for items costing less than \$3,000 that are no longer supported by base supply (e.g., rags, metal brushes, tools). There is an exception to this standard, where an item costing up to \$25,000 can be purchased with Air Logistics Center equipment specialist/item manager approval. This exception is rarely exercised, but is available for situations when maintenance personnel are unable to acquire an aircraft part in a reasonable timeframe, and the part is required to repair a grounded aircraft. A three-year average is used to project future funding requirements in building the GPC factor. This three-year averaging process was incorporated within the last ten years following lessons learned and in an effort to smooth out anomalies.

AVPOL: Aviation Petroleum, Oils, and Lubrications are resources used for aircraft servicing. Building the AVPOL factor is conducted using a five-year average to project future requirements and funding. As in FH GPC calculations, lessons learned within the last ten years led planners to use a five-year average to smooth out anomalies.²⁴

These four components—MSD, GSD, FH GPC, and AVPOL—build the U.S. Air Force CPFH budgetary calculations. However, CPFH is only one of seven elements in the U.S. Air Force Cost Analysis Improvement Group (CAIG). The Office of the Secretary of Defense allows each service to either use

²⁴ Richard Jones, Headquarters U.S. Air Force Special Operations Command, e-mail communication to authors, 23 March 2012.

six or seven elements for its service-specific CAIG. Much more complicated than CPFH, the CAIG deals with elements such as manpower, base operating support, and aircraft modifications.²⁵

B. PURPOSE AND SCOPE

The purpose of this thesis is to provide an analysis of the costs and benefits associated with procuring, developing, and employing low-cost light-fixed-wing and medium-fixed-wing aircraft to fulfill the SOF aviation mission. The current economically constrained environment justifies exploring the worth of cost-effective platforms that can efficiently support SOF core activities by employing specialized air mobility; ISR; and precision aerospace fires. This study examines whether light-fixed-wing and medium-fixed-wing aircraft allow nations and/or alliances to accomplish effective SOF aviation mission sets by possessing hallmark SOF aviation qualities. In addition, the study will explore the benefits associated with multi-mission aircraft when compared to multiple single-role aircraft. Figure 4 lists the select aircraft that will be examined in subsequent chapters.

²⁵ Edward G. Keating and Frank Camm, "How Should The U.S. Air Force Depot Maintenance Activity Group be Funded: Insights from Expenditure and Flying Hour Data," 5, *The RAND Corporation*, 2002, <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA408964>.

| PROPOSED AVIATION PLATFORMS FOR EXAMINATION | |
|--|--|
| Light-fixed Wing | |
| Viking Air DHC 6-400 Twin Otter | |
| Cessna 208 Caravan | |
| Britten-Norman BN2T-4S Defender | |
| Pilatus PC-6 | |
| Medium-fixed Wing | |
| Alenia Aeramacchi C-27J Spartan | |
| CASA/IPTN CN-235 | |
| EADS CASA C-295 | |

Figure 4. List of select light-fixed-wing and medium-fixed-wing aircraft to be examined in this study for SOF utility

Due to perceived costs and aircraft utility, this study will focus exclusively on light- and medium-fixed-wing aircraft and not on large-fixed-wing aircraft over 50,000 pounds max gross takeoff weight. The ideal special operations aircraft should be able to operate in varying locations, and it should not be restricted by airfield size and conditions. Many future trouble spots around the world are limited in quality airfields and most are not able to accommodate large, heavy-weight aircraft. A 2006 U.S. Air Force study found that of the 10,326 airfields in 42 identified priority countries, 90% were unable to accommodate a C-130 or larger aircraft due to pavement or landing surface strengths. In addition, 45% of the runways were less than 3,000 feet in length.²⁶

Cost may also prohibit many smaller nations from operating larger, more expensive aircraft. In addition, because this study will focus on U.S. allies and alliances, aircraft produced by Russia, China, and other countries with contentious relationships with the U.S. will not be considered or reviewed. While

²⁶ Headquarters, U.S. Air Force, "Posturing the Air Force for the Long War: A Strategic Perspective," (pre-decisional briefing, Air Staff, Pentagon, September 13, 2006).

there are many manufacturers worldwide that supply aircraft to individuals, businesses, and militaries, this study will focus on aircraft produced by larger aircraft manufacturers with a proven history of military support. Some small aircraft builders provide excellent products, but the audience of this study may favor a larger aircraft manufacturer. An organization, like NATO SOF Headquarters (NSHQ), that requires a SOF Air Wing will demand aircraft that can be produced rapidly and in mass,²⁷ with readily available replacement parts, and have technicians who are familiar with the aircraft systems.

C. LITERATURE

The following section presents the literature relating to this inquiry by way of three sections: Inherent SOF Aviation Capabilities, Benefits of a Multi-Mission Aircraft, and Possible Existing Solutions. The review is designed to address Inherent SOF Aviation Capabilities and Light-Fixed-Wing and Medium-Fixed-Wing Aircraft separately. Finally, the review summarizes relevant literature on Possible Existing Solutions.

1. Inherent SOF Aviation Capabilities

The literature on Inherent SOF Aviation Capabilities is large and composed primarily of empirical literature and military doctrine. While what composes SOF aviation capabilities may vary by nation, a few key task sets are consistently included. Generally, SOF aviation capabilities are considered to enable activities conducted by specially organized, trained, and equipped aviation forces to support military objectives through unconventional means in hostile, denied, or politically sensitive areas. The *United States Air Force Doctrine Document 1* defines SOF aviation as “the use of airpower operations (denied territory mobility, surgical firepower, and special tactics) to conduct the following special operations functions: unconventional warfare, direct action,

²⁷ Typical government acquisitions processes take years to field aircraft. For the customarily immediate need for SOF capabilities, aircraft procurements within months vice years are critical. See notes on USSOCOM’s U-28 program below.

special reconnaissance, counter-terrorism, foreign internal defense, psychological operations, and counter proliferation.”²⁸ Similarly, NATO’s, *AJP-3.5: Allied Joint Doctrine for Special Operations* defines SOF air operations as primarily “infiltration/extraction and resupply via fixed-wing and rotary-wing aircraft.”²⁹ In addition NATO’s *AJP-3.5* states, “other special air activities may include close air support, intelligence, surveillance, target acquisition, and reconnaissance, air-to-air refueling, and personnel recovery, including medical evacuation (MEDEVAC), for special operations air, ground, and maritime forces.”³⁰

While *United States Air Force Doctrine Document 1* states SOF aviation tasks are primarily conducted in low-visibility, covert, or clandestine military actions, they have also been conducted across the full spectrum of conflict, independently or in conjunction with conventional forces.³¹ Many of the references contain supporting information regarding what makes SOF aviation unique. Most of the authors—among them Admiral James Stavridis, Supreme Allied Commander, Europe; Admiral William H. McRaven, Commander U.S. Special Operations Command; Lieutenant General Frank Kisner, NATO Special Operations Headquarters Commander; and Richard Newton, instructor of irregular warfare and special operations planning at the Joint Special Operations University—agree that like ground and maritime special operations, SOF aviation is not defined only by the equipment utilized, but rather by the unconventional and innovative ways aircrews employ whatever aircraft they have at their disposal. In addition, highly trained airmen, who employ their aircraft in ways unexpected by their adversaries, are the driving force behind SOF aviation successes. Undoubtedly, having the right aircraft capabilities do still play a significant role in the aircrews’ success.

²⁸ U.S. Department of the Air Force, *Air Force Doctrine Document 1: Air Force basic Doctrine, Organization, and Command*, (November 2003): 53.

²⁹ NATO, *AJP-3.5: Allied Joint Doctrine for Special Operations*, (January 2009): 2–6.

³⁰ NATO, *AJP-3.5*, 2–6.

³¹ U.S. Department of the Air Force, *Doctrine Document 1*, 53.

2. Benefits of a Multi-Mission Aircraft

The literature concerning the benefits of low-cost, multi-mission aircraft is not voluminous. Again, the literature is primarily empirical in nature. A recent document produced by the U.S. Air Force draws great attention to the current financial constraints the United States and other nations are facing. The *U.S. Air Force Structure Changes: Sustaining Readiness and Modernizing the Total Force* document explains that the changing geopolitical environments and fiscal circumstances of the United States and our allies merit a reassessment of defense funding priorities and strategies. Many nations are plagued with domestic financial problems while still needing to maintain a modern defense force to combat domestic, regional, and transnational threats. As Lieutenant General Kisner declared in his Speech to XXI Seminario Internacional Catedra Alfredo Kindelan, “a synchronized ... *Smart Defense* approach ... is the key to success.”³² In addition, the *U.S. Air Force Force Structure Changes: Sustaining Readiness and Modernizing the Total Force* document addresses pending force structure changes and calls for an increased emphasis on multi-mission platforms as a cost saving tool. The document states, “Multi-role platforms provide more utility across the range of the potential missions for which [the U.S. Air Force is] directed” while the U.S. Air Force plans to “retire all aircraft of a specific type, allowing us to also divest the unique training and logistic support structure for that aircraft.”³³

3. Possible Existing Solutions

a. Light-Fixed-Wing Aircraft

The concept of fielding light-fixed-wing aircraft in lieu of larger, more complex platforms is not new. Even though technology had left propeller-driven aircraft behind in the jet age, the United States military has fielded several

³² Kisner, “Special Air Speech.”

³³ U.S. Department of the Air Force, *USAF Force Structure Changes: Sustaining Readiness and Modernizing the Total Force* (February, 2012): 3.

light-fixed-wing platforms to complement its airborne fleet. These aircraft have displayed great mission success despite their lesser capabilities such as speed, stealth, maneuverability, operating altitude, firepower, and defensive systems.

Since 2006, the U.S. Air Force has fielded three separate light-fixed-wing aircraft to provide lift (PC-12, M-28) and intelligence, surveillance, and reconnaissance (U-28) support to SOF. Additionally, the DoD has given consideration to fielding an array of aircraft dedicated to attack missions. This study will use the aforementioned Air Force Special Operations Command (AFSOC) acquisitions in addition to the following proposed initiatives to provide a critical analysis of the ideal fielding options for a SOF air wing.

The “Light Attack/Armed Reconnaissance Aircraft” Program: Although originally envisioned in 2009 as an effort that would procure as many as 100 airplanes, the Light Attack/Armed Reconnaissance Aircraft initiative was significantly curtailed in 2010.³⁴ According to the U.S. Air Force Aeronautical Systems Center’s *Capability Request for Information for Air Combat Command (ACC) Light Attack/Armed Reconnaissance (LAAR)* report, former U.S. Air Force Chief of Staff General Norton Schwartz considerably reduced the expected purchase to only fifteen aircraft.³⁵ Furthermore, according to Greg Grant, editor at Military.com, in his article, “Schwartz Shoots Down COIN Plane,” General Schwartz also “re-purposed” the program strictly for “building partner capacity” (e.g., training foreign pilots), ruling out use of the aircraft in direct combat.³⁶

The “Afghan Light Air Support Aircraft” Program: Like the Light Attack/Armed Reconnaissance Aircraft, Air Force Materiel Command’s Aeronautical Systems Center manages the Afghan Light Air Support program. According to the Assistant Secretary of the Air Force for Acquisition and Deputy

³⁴ Stephen Trimble, “Rivals Not Deterred by USAF Shift on Turboprop Fighters,” *Flightglobal*, (15 September 2010), retrieved 10 October 2012, <http://www.flightglobal.com/news/articles/rivals-not-deterred-by-usaf-shift-on-turboprop-fighters-347341/>.

³⁵ U.S. Air Force Aeronautical Systems Center, *Capability Request for Information for Air Combat Command (ACC) Light Attack/Armed Reconnaissance (LAAR)*, Air Force Materiel Command (2010).

³⁶ Greg Grant, “Schwartz Shoots Down COIN Plane,” *DoD Buzz* (May 6, 2010).

Undersecretary of the Air Force for International Affairs' report, *Afghanistan Light Air Support & Basic Trainer/Light Lift Status Update, Version 2*, this initiative will procure twenty light attack/advanced trainer aircraft for the Afghan Air Force (formerly known as the Afghan National Army Air Corps).³⁷ The U.S. Air Force plans to begin accepting deliveries in 2013 and receive its last order in 2015.³⁸ The *Defense Technology* article "Super Tucano Wins USAF's Light Attack Contest" reported that formal flight evaluations of the Embraer A-29 Super Tucano and the Hawker-Beechcraft AT-6 were conducted, and the DoD awarded the \$355 million contract to Embraer (Sierra Nevada Corporation) in late 2011.³⁹ However, Hawker-Beechcraft filed suit against the U.S. Air Force in the United States Court of Federal Claims, seeking legal review of its elimination from the competition. In light of the expected legal review, the U.S. Air Force issued a stop work order for the Afghan Light Air Support Aircraft contract that was awarded to Sierra Nevada Corporation. As of June 2012, both parties had filed motions to the Court and legislation is pending.⁴⁰

The "AT-6" Program: This is a congressionally mandated public/private cooperative effort administered by the U.S. Air National Guard and Air Force Reserve Test Center in Tucson, Arizona. Robert Dorr reported in his article, "AT-6 Demonstration a Good Deal," that it is designed to explore the potential capabilities of light attack aircraft with the Hawker-Beechcraft AT-6 as a

³⁷ Assistant Secretary of the Air Force for Acquisition and Deputy Undersecretary of the Air Force for International Affairs, *Afghanistan Light Air Support & Basic Trainer/Light Lift Status Update, Version 2* (September 2010), 4.

³⁸ Assistant Secretary of the Air Force for Acquisition and Deputy Undersecretary of the Air Force for International Affairs, *Afghanistan Light Air*, 5.

³⁹ John Reed, "Super Tucano Wins USAF's Light Attack Contest," *Defense technology*, December 31, 2011, <http://defensetech.org/2011/12/31/embraer-wins-usafs-light-attack-contest/>.

⁴⁰ Andrea Shalal-Esa, "U.S. Air Force Says it Briefed Afghan Plane Bidders," *Reuters*, June 13, 2012, retrieved 10 September 2012, <http://www.reuters.com/article/2012/06/14/us-afghanistan-planes-idUSBRE85D01S20120614>.

test platform.⁴¹ Separately, Hawker-Beechcraft also proposed the AT-6 as a solution for both the Afghan Light Air Support and Light Attack/Armed Reconnaissance Aircraft programs.⁴²

The “Imminent Fury” Program: This joint U.S. Air Force, Navy, USSOCOM project utilized a modified Embraer A-29 Super Tucano to explore light attack aircraft capabilities tailored specifically for support of SOF ground units. Despite rapid technical progress, an ongoing pilot qualification program, and an expansion plan that included four additional aircraft beyond the prototype, James H. Flatley reported in The Hill’s Congress Blog that this project was abruptly cancelled in 2010 for reasons that remain unclear.⁴³

The “OA-X” Program: This is the U.S. Air Force Air Combat Command’s generic designator for a yet-to-be-named observation/attack aircraft that would perform many of the tasks required of close air support aircraft in irregular warfare. The anticipated capabilities for the OA-X closely match those of the Light Attack/Armed Reconnaissance Aircraft. The employment concepts for the aircraft are outlined in two Air Combat Command white papers, “The Case for OA-X” and “The OA-X Enabling Concept.”⁴⁴ Since the Air Combat Command papers describe the OA-X as a possible follow-on to the Light Attack/Armed Reconnaissance Aircraft, the Light Attack/Armed Reconnaissance Aircraft requirements are a useful starting point. These requirements, as stated in the 2009 Capabilities Request for Information, included twenty-five imperatives and nine desirables. Figure 5 lists some of the highlights.

⁴¹ Robert F. Dorr, “AT-6 Demonstration a Good Deal,” *Air Force Times*, April 30, 2010.

⁴² Robert F. Dorr, “AT-6 Texan II Armed Aircraft Showing Progress on Several Fronts,” *Defense Media Network*, March 15, 2011.

⁴³ James H. Flatley, “Meeting the Needs of the Warfighter from the Air,” The Hill’s Congress Blog, entry posted May 4, 2011.

⁴⁴ Lt. Col. David J. Torres-Laboy and Lt. Col. Michael W. Pietrucha, *Air Combat Command White Paper: The Case for OA-X* (Washington, DC: ACC/A3D Joint Air Ground Combat Division, 2009); Michael W. Pietrucha, Mike Saridakis and J. David Torres-Laboy, *OA-X Enabling Concept* (Langley AFB, VA: Air Combat Command, 2008).

- Jet fuel burning engines
- An electro-optical sensor
- Aerial gunnery capability
- Precision weapons capability
- Day/night visual flight rules and instrument flight rules capability
- Capability to operate from semi-prepared surfaces (dirt, grass, gravel)
- Single-pilot capability with tandem seating, provisions for second pilot

Figure 5. List of select OA-X Requirements⁴⁵

There is a large amount of literature on the benefits of light-fixed-wing aircraft (e.g., cost, simplicity, efficiency). For this reason, the focus of this literature review and platforms for examination has been narrowed down in scope. Through lessons learned documentation and literature from the above fielded/proposed aircraft, and via a capabilities-based approach, this study will recommend the ideal light-fixed-wing aircraft to supplement a SOF air wing.

b. Medium-Fixed-Wing Aircraft

There is relatively little literature on the SOF utility of medium-fixed-wing aircraft. Sources primarily consist of government and industry-funded conceptual studies and analyses. Currently, United States Southern Command (USSOUTHCOM) is teaming in an effort with Air Force Research Labs, AFSOC, and Alliant Techsystems Inc. (ATK) to develop a lightweight, low-cost gunship modification, nicknamed “a gunship in a box.” This effort will give countries a roll-on/roll-off side firing weapons capability that can be used on any number of existing cargo aircraft. In addition, in 2008 AFSOC developed a plan for a medium sized AC-27J multi-mission “gunship-lite” aircraft. AFSOC’s AC-XX Analysis of Alternatives provided initial cost analysis and platform comparisons prior to the program being cancelled, per the direction of Congress.⁴⁶ Finally,

⁴⁵ U.S. Air Force Aeronautical Systems Center, *Capability Request for Information for Air Combat Command (ACC) Light Attack/Armed Reconnaissance (LAAR)*, Air Force Materiel Command (2010): 7–10.

⁴⁶ U.S. Air Force Special Operations Command, *AC-XX Analysis of Alternatives*, (June 2, 2008).

NATO recently contracted for a study on what a potential NATO SOF Air Group should consist of. The *Special Operations Air Group: Concept for Development and Organization Study* provides an initial look at specific air capabilities NATO SOF should consider striving to achieve. While the study does briefly comment on the benefits of a multi-role platform, analysis is focused exclusively on intelligence, surveillance, target acquisition, and reconnaissance and air mobility specific platform capabilities. No analysis is provided on the utility and merit of a medium-fixed-wing platform.⁴⁷

To fully evaluate potential solutions, an examination of existing U.S. and NATO aircraft cost data is required for comparison. The U.S. Air Force currently maintains a small fleet of C-27J joint cargo aircraft and the U.S. Coast Guard operates a small fleet of CASA aircraft. Records and reports from these programs should be able to provide general cost data, logistics requirements, and manpower estimates for potential solution aircraft.

D. METHODOLOGY

1. Empirical Comparisons

The first phase of this study will begin in Chapter II with a review of empirical observations and qualitative data relating to SOF aviation. In this section, the study will identify how the battlefield of today is changing and why SOF is ideally suited to combat emerging threats. The argument will be made that SOF aviation must play a role commensurate with ground SOF investments in addressing new threats. In addition, inherent traits and “hallmark qualities” of SOF aircraft will be assessed through a review of U.S. and coalition SOF doctrine. Finally, Chapter VI of this study will review a small number of SOF aviation operational successes in an attempt to further highlight relative effectiveness of the identified hallmark capabilities. The AFSOC U-28, Non-Standard Aviation, and AC-130W programs will be examined, along with

⁴⁷ NATO Special Operations Headquarters, *Special Operations Air Group: Concept for Development and Organization* (April 22, 2010).

initiatives such as USSOUTHCOM/Air Force Research Lab's "gunship in a box program" and Jordan's CN-235 small SOF aerial gunship program.

2. Qualitative Comparisons

The second phase of this study is structured as a qualitative comparative analysis of light and medium-fixed-wing aircraft in Chapters III and IV. To begin, the study will present a broad overview of candidate aircraft platforms. Following an overview, each of the alternatives will be evaluated using a bivariate cost comparison that examines both raw aircraft acquisition cost and basic aircraft CPFH. For the purpose of this study neither organic versus contract maintenance support cost or any research and development costs associated with modifying the aircraft will be considered. Following the cost comparison, an effectiveness analysis will gauge aircraft performance dimensions and capabilities. These dimensions and capabilities are then evaluated against the hallmark SOF aviation qualities, listed in Chapter II, and a NSHQ-derived desired and minimum aircraft capabilities list. Finally, a short discussion on aircraft availability will be performed. Using the performance dimensions and the bivariate cost comparison, the study will analyze and grade light-fixed-wing and medium-fixed-wing aircraft that are viable candidates for a SOF aviation platform. Finding will be summarized and recommendations will be made in Chapter V. Data for this phase was gathered by discussions with subject matter experts and industry representatives.

3. Recommendations

The final chapter of this study will provide a series of recommendations based on the previous analysis. Observations, educated predictions, and generalized conclusions about the applicability of light-fixed-wing and medium-fixed-wing aircraft as cost effective SOF aviation platforms will be made. These recommendations may be utilized by NATO members and other U.S. allies if they choose to pursue fixed wing SOF aircraft.

E. SUMMARY

Acquiring and employing SOF aviation assets is an expensive venture for nations to undertake. Because the nature of irregular and unconventional threats to nations is changing, it is important for national leaders to carefully select adequate and sustainable SOF aircraft to support their SOF ground component. This study proposes that militaries can acquire low-cost, commercially available-off-the-shelf aircraft, and with slight modifications utilize them to satisfy basic SOF aviation roles. While the United States may be able to afford top-of-the-line mission-specific SOF aircraft, lower-cost alternatives can suffice for allies with lesser defense budgets.

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II. WHY SOF AVIATION?

*Change is one of the few constants in the new environment, which is why the agile and innovative mindset of SOF and SOCOM is so critical to helping secure the future.*⁴⁸

—Michael D. Lumpkin, 2011

Acting Assistant Secretary of Defense for
Special Operations/Low-Intensity Conflict

As most modern conflicts are of an irregular nature, special operations forces (SOF) will play a growing role before, during, and after these wars. While many U.S. allies have capable SOF ground forces, relatively few have any sort of dedicated SOF aviation support. In order to reap the full benefits that special operations bring to the table, nations should consider investing in low cost light- and medium-fixed-wing aircraft to accompany their SOF ground components. In doing so, nations should consider that there are certain hallmark qualities that SOF aircraft should possess in order to accomplish basic SOF mission sets (i.e., specialized air mobility; intelligence, surveillance, and reconnaissance (ISR); and precision aerospace fires). Investing in properly equipped and capable aircraft will ensure the future success of U.S. allies in navigating the irregular warfare battlefield.

A. CHANGES IN MODERN WARFARE

Many defense and security establishments around the world recognize that irregular conflicts are on the rise and may dominate warfare for the foreseeable future, while the number of conventionally-fought wars is declining. The 2006 United States Quadrennial Defense Review (QDR) points out, “the long war against terrorist networks will extend far beyond the borders of Iraq and Afghanistan and includes many operations characterized by irregular warfare—

⁴⁸ The Future of U.S. Special Operations Forces: Ten Years After 9/11 and Twenty-Five Years After Goldwater-Nichols: Hearing Before the Committee on Armed Services. 112th Congress 36 (2011) (statement of Michael D. Lumpkin, Assistant Secretary of Defense for Special Operations/Low-Intensity Conflict).

operations in which the enemy is not a regular military force of a nation-state.”⁴⁹ In addition, Sebastian Gorka, Associate Professor at the National Defense University, points out, “no longer is the enemy limited by the resources his national population represents.”⁵⁰ The definition of war that pertains only to nations in a state-on-state conventional war is dead.

These irregular threats, as defined by the United States Department of Defense *Joint Publication 1–02*, present “a violent struggle among state and non-state actors for legitimacy and influence over the relevant populations. Irregular warfare favors indirect and asymmetric approaches, though it may employ the full range of military and other capabilities, in order to erode an adversary’s power, influence, and will.”⁵¹ Allies of the United States will be forced to confront a growing number of irregular threats through a variety of conventional and unconventional military means.⁵²

Dr. James Russell, Associate Professor of National Security Affairs at the United States Naval Postgraduate School, explains that conventional interstate warfare between developed states has been on the decline since 1990. In its place, intra-societal and ethnically organized warfare is on the rise.⁵³ Russell goes on to say, “Shaped by political disputes, we have witnessed multiple attempts at ethnic separatism through violent means and clashes created by Islamic militants pursuing an anti-globalization and anti-modernity agenda. These wars tend to involve actors waging what could be characterized as irregular war in that the war is not waged between organized state-based militaries.”⁵⁴

⁴⁹ U.S. Department of Defense, *Quadrennial Defense Review Report* (February 6, 2006): 1.

⁵⁰ Sebastian L.V. Gorka, “The Age of Irregular Warfare: So What,” *Joint Forces Quarterly* 58, 3rd quarter (2010): 35.

⁵¹ U.S. Department of Defense, *Joint Publication: Department of Defense Dictionary of Military and Associated Terms*, (July 15, 2012): 163.

⁵² U.S. Department of Defense, *Irregular Warfare: Countering Irregular Threats Joint Operating Concept Version 2.0* (May 17, 2010): 8.

⁵³ James A. Russell, “Irregular Warfare and Future War: Strategy and Defense Planning,” *Strategic Insights*, 10 (2011): 94.

⁵⁴ Russell, “Irregular Warfare Future,” 94.

In his 2007 treatise on modern warfare, retired British Army General Sir Rupert Smith echoed Russell's warnings. Smith suggests that a paradigm shift in war has occurred, and war of the traditional nature no longer exists. He writes, "War as cognitively known to most non-combatants, war as battle in a field between men and machinery, war as a massive deciding event in a dispute in international affairs: such war no longer exists."⁵⁵ Instead, Smith states, the world is in a new era of conflict—"wars among the people."⁵⁶ Smith believes these wars are characterized by six trends:⁵⁷

1. The ends for which we fight are changing from the hard objectives of interstate industrial war that decide a political outcome, to more malleable objectives of individuals and societies that are not states.
2. We fight among the people, not on the battlefield.
3. Our conflicts tend to be timeless, even unending.
4. We fight so as to preserve the force rather than risking all to gain the objective.
5. On each occasion, new uses are found for old weapons that were constructed for use in industrial war against soldiers and heavy armament.
6. The sides are mostly non-state, comprising some form of multi-national grouping against some non-state party or parties.

These cautions are transferable to U.S. partners and alliances such as NATO. If the warnings of Russell, Smith, and others are reasonable—that conflict has changed over the last quarter century away from large Westphalian industrialized battles—then forms of unconventional military power should be more thoroughly explored. These new threats are less apparent, more difficult to anticipate, and threaten to undermine international stability through persistent "low-boil" conflict. Given the prevalence of irregular threats in the current and

⁵⁵ Rupert Smith, *The Utility of Force* (New York: Alfred A Knopf, 2007), 3.

⁵⁶ Smith, *The Utility of Force*, xiii.

⁵⁷ Smith, *The Utility of Force*, 24

expected future operating environment, the U.S. government and its allies must become as proficient in addressing irregular threats as they are in confronting conventional or regular threats.

B. SOF: THE RIGHT FORCE FOR THE JOB

As Russell points out in his “Irregular Warfare and Future War,” the U.S. government is restructuring its military toward a force better equipped to deal with growing irregular threats. In the 2009 *Quadrennial Roles and Missions (QRM) Report*, the Department of Defense (DoD) established Irregular Warfare as one of its six core mission areas.⁵⁸ The 2009 *QRM* stresses, “Irregular Warfare encompasses operations in which the joint force conducts protracted regional and global campaigns against state and non-state adversaries to subvert, coerce, attrite, and exhaust adversaries rather than defeat them through direct conventional military confrontation.”⁵⁹

In response to U.S. government policy makers, in 2010 the United States Joint Forces Command and the United States Special Operations Command co-authored a Joint Operating Concept (JOC) entitled *Irregular Warfare (IW): Countering Irregular Threats v. 2.0*. This *IW JOC* was written as part of a larger effort to institutionalize the skills and abilities needed to combat adaptive adversaries, such as terrorists, insurgents, criminal networks, and states that increasingly resort to forms of irregular warfare. These adversaries often utilize methods such as guerrilla warfare, sabotage, and subversion. To combat these activities, the *IW JOC* highlighted five principal activities or operations that can be utilized. These are counterterrorism, unconventional warfare, foreign internal defense (FID), counterinsurgency (COIN), and stability operations.⁶⁰ The *IW JOC* states, “Rather than treating them as five separate activities or operations,

⁵⁸ Russell, “Irregular Warfare Future,” 96.

⁵⁹ U.S. Department of Defense, *Quadrennial Roles and Missions Report* (January 2009): 5.

⁶⁰ U.S. Department of Defense, *Irregular Warfare JOC*, 9.

however, the joint force will blend these complementary activities into a coherent campaign tailored to the specific circumstances.”⁶¹

While these five activities can often be conducted by general purpose forces, they fall, by and large, under the charge of SOF. The United States DoD *Joint Publication 3–05: Special Operations* outlines eleven core activities (presented in Figure 6) that SOF are “specifically organized, trained, and equipped to accomplish.”⁶² Four of the five “countering irregular warfare activities” (presented in red in Figure 6) in the *IW JOC* are on the SOF core activities list. *Joint Publication 3–05* further points out that “while conventional forces also conduct many of these activities (e.g., foreign internal defense (FID), security force assistance (SFA), counter insurgency (COIN), and counter terrorism), SOF conduct them using specialized tactics, techniques, and procedures, and to unique conditions and standards in a manner that complement conventional forces capabilities.”⁶³

- | Special Operations Core Activities |
|---|
| ▪ Direct Action |
| ▪ Special Reconnaissance |
| ▪ Counterproliferation of Weapons of Mass Destruction |
| ▪ Counterterrorism |
| ▪ Unconventional Warfare |
| ▪ Foreign Internal Defense |
| ▪ Security Force Assistance |
| ▪ Counterinsurgency |
| ▪ Information Operations |
| ▪ Military Information Support Operations |
| ▪ Civil Affairs Operations |

Figure 6. List of special operations core activities as defined in *Joint Publication 3–05: Special Operations*⁶⁴

⁶¹ U.S. Department of Defense, *Irregular Warfare JOC*, 17.

⁶² U.S. Joint Chiefs of Staff, *JP 3–05*, II-5.

⁶³ U.S. Joint Chiefs of Staff, *JP 3–05*, II-5.

⁶⁴ U.S. Joint Chiefs of Staff, *JP 3–05*, II-6.

According to the *IW JOC and Joint Publication 3-05*, the United States and many of its allies are placing a greater emphasis on both SOF and COIN capability.⁶⁵ Since 9/11, special operations and the forces needed to conduct these have become a prominent part of the United States and its allies' military strategies. In order to combat growing irregular threats, many nations are turning to specially equipped and trained forces to operate in these ambiguous and dynamic environments. In his 2011 speech to the XXI Seminario Internacional Catedra Alfredo Kindelan, Lieutenant General Frank Kisner, NATO SOF Headquarters (NSHQ) Commander, elaborated that "SOF allow national and collective defense establishments to retain freedom of action through employing a force with traditionally a smaller footprint than their conventional counterparts, and therefore one which may be more politically acceptable to both the providing nation, and to the nation in which operations are conducted."⁶⁶ Lt. Gen. Kisner further stated, "a nation unwilling or unable to employ SOF may be faced with conventional alternatives that may not possess the geographical reach, the required rapidity of response, the ability to apply force discriminately, or the appropriate level of discreetness."⁶⁷

C. SOF AVIATION: THE MISSING LINK

1. A Critical Shortfall for U.S. Allies

While many U.S. allies' ground SOF capabilities continue to grow, their SOF aviation capabilities are insufficient to support them.⁶⁸ Of the 26 NATO nations possessing a dedicated SOF ground force, only six are able to provide SOF air support in any capacity: the United States, Italy, Canada, United

⁶⁵ Scott Morrisson, "Closing the Gap," *CPM Forum: NATO Special Operations Forces*, 2nd edition (2011): 6-7.

⁶⁶ Lieutenant General Frank Kisner, "Special Air Warfare and a Coherent Framework for NATO SOF Aviation" (Speech to XXI Seminario Internacional Cátedra Alfredo Kindelán, Madrid, Spain, November 14, 2011).

⁶⁷ Kisner, "Special Air Warfare."

⁶⁸ Kisner, "Special Air Warfare."

Kingdom, Turkey, and France.⁶⁹ This presents a problem when considering NATO's declared emphasis on addressing "instability or conflict beyond NATO borders [that] can directly threaten Alliance security, including by fostering extremism, terrorism, and trans-national illegal activities such as trafficking in arms, narcotics and people."⁷⁰ Without proper SOF aviation support, history indicates the probability of success in these environments is low.⁷¹

Of the three principal tasks assigned to NATO SOF—special reconnaissance, direct action, and military assistance—SOF aviation is essential to the first two. Also, SOF air transport plays a role in military assistance and related SOF activities such as air-land integration, personnel recovery, and forward arming and refueling point (FARP) operations.⁷² The NSHQ *Special Air Warfare Manual* states, "the primary mission of special operations air forces is enhanced air mobility—specialized air transport activities via fixed-wing, rotary-wing, or tilt-rotor aircraft."⁷³ Ground SOF must have means of transport to the area of operation, and air transport must be an option. The *North Atlantic Treaty Organization Special Operations Forces Study* further points out, "SOF mobility needs are diverse and essential to mission success."⁷⁴ The study emphasizes "when considering mobility requirements, nations should do so taking into account the pragmatic declaration from the NATO [*Comprehensive Political Guidance*] CPG that attacks may increasingly originate from outside the Euro-Atlantic area."⁷⁵

⁶⁹ Lt. Col. Mike Maksimowicz, e-mail message to authors, March 12, 2012.

⁷⁰ NATO, "Active Engagement, Modern Defence," November 19, 2010, http://www.nato.int/cps/en/natolive/official_texts_68580.htm.

⁷¹ NATO Special Operations Coordination Centre, *Special Operations Forces Study*, 17.

⁷² NATO Special Operations Headquarters, *Special Air Warfare Manual*, (March 2010) 6–11.

⁷³ NATO Special Operations Headquarters, *Special Air Warfare*, 5–6.

⁷⁴ NATO Special Operations Coordination Centre, *Special Operations Forces Study*, A1.

⁷⁵ NATO Special Operations Coordination Centre, *Special Operations Forces Study*, A1.

Although resource intensive, air assets are essential to the conduct of ground SOF operations.⁷⁶ The May 2011 *NATO SOF Air Mobility Study* found:

[H]istorical SOF air enabler shortfalls negatively impact current NATO SOF operations and severely restrict NATO SOF's ability to support future operations. Furthermore, a conclusion of the study was that shortfalls within many individual NATO member nations were of such magnitude that in addition to the NSHQ's efforts to build and enhance national SOF aviation capabilities through common doctrine, standards, and tactics/techniques/procedures, the establishment of a pooled NATO SOF operational aviation capability would further help mitigate the SOF air enabler shortfall.⁷⁷

Besides specialized air mobility, other key special air warfare activities such as ISR and close air support (CAS) also play a vital role in special operations. Special operations are normally planned in great detail and require unfettered access to ISR assets. Lack of timely, detailed, and dedicated intelligence for the SOF operator can lead to mission failure or compromise.⁷⁸ Similarly, dedicated CAS allows for greater battlefield flexibility and immediate attention to time-sensitive targets. Given these considerations, and the recognition that SOF must be able to rapidly generate and project scalable force packages with organic assets, it is essential that a SOF aviation capability be pursued by U.S. allies, such as NATO members.

2. Low-Cost Considerations for SOF Aviation

Even fixed-wing aircraft can sometimes prove to be prohibitively costly to operate. The NATO SOF Headquarters' *Special Air Warfare Manual* further explains:

⁷⁶ NATO Special Operations Coordination Centre, *Special Operations Forces Study*, A2.

⁷⁷ Kisner, "Special Air Warfare."

⁷⁸ NATO Special Operations Coordination Centre, *Special Operations Forces Study*, A6-A7.

While specialized aircraft have an important niche in extending the capabilities of special air warfare forces, such high-end capabilities are costly to procure and to sustain in terms of equipment/logistics and aircrew training. Combat experience has demonstrated that technologically sophisticated aircraft are not required for every special air warfare mission.⁷⁹

Most U.S. allies will not require a fleet of expensive MC-130 Combat Talons/Shadows. While the AFSOC MC-130 platform is most often utilized to conduct airlift missions in support of SOF, not all missions require such a technically advanced and expensive aircraft. While AFSOC is “flying the wings off its Combat Talons,” as Richard D. Newton writes in *JSOU Report 06–8: Special Operations Aviation in NATO*, many missions could be accomplished by simpler, more cost-effective airframes.⁸⁰ A similar low-cost, low-technology aircraft could fulfill the needs of many allies’ SOF air component.

First, when considering the economic constraints of many U.S. allies, the SOF aircraft that the United States can afford may be beyond their budgetary reach. For example, Australia’s 2012 defense budget is \$24.2 billion, or approximately 3% of that of the United States.⁸¹ It is not realistic to expect Australia and allies with similar defense budgets to acquire and operate a varied and diverse fleet of highly specialized SOF aircraft. The need for low-cost SOF aircraft is compounded by Russell’s warning: “[O]ver the next quarter century, developed and developing states may follow the lead of Europe and start spending less on defense with a resultant reduction in the sizes of their conventionally structured militaries.”⁸² Second, most U.S. allies do not strive to unilaterally project SOF power globally, as the United States does. Their armed

⁷⁹ NATO Special Operations Headquarters, *Special Air Warfare*, 3.

⁸⁰ Richard D. Newton, *JSOU Report 06–8: Special Operations Aviation in NATO* (Hurlburt Field, FL: The JSOU Press, 2006), accessed March 21, 2012, http://usacac.army.mil/cac2/cgsc/carl/docrepository/JSOU_Report_06_8.pdf.

⁸¹ Australian Strategic Policy Institute, “The Cost of Defence: Defence Budget Brief 2011–2012,” vi, http://www.aspi.org.au/publications/publication_details.aspx?ContentID=294.

⁸² Russell, “Irregular Warfare and Future,” 95.

forces are inwardly focused on border security, internal stability, and regional alliances.

For these two reasons—(1) defense budget constraints and (2) inward focus on border security—nations desiring a SOF aviation capability should consider a more cost-effective solution to fixed-wing SOF aviation. Before investing in expensive “niche” aircraft, their defense ministries should explore which SOF aviation capabilities are necessary to sufficiently accomplish their national security objectives. Programs designed around lower cost commercial of the shelf (COTS) aircraft, aircraft with low cost per flying hour (CPFH), and aircraft equipped to handle carry on/carry off equipment as the mission dictates should be evaluated. Finally, allies should explore recent United States successes with multi-mission aircraft, or aircraft that can be easily equipped to perform many mission sets [i.e., transport, CAS, or ISR].

D. INHERENT TRAITS OF SOF AVIATION

Of the five SOF truths embraced by USSOCOM, the first is “Humans are more important than hardware.”⁸³ The NATO Special Air Warfare Manual agrees that it is the capabilities of people that make special air warfare successful, and it further states, “[c]ombat experience has demonstrated that technologically sophisticated aircraft are not required for every special air warfare mission.”⁸⁴ Accordingly, low-cost COTS aircraft could be capable of successfully executing SOF aviation operations, provided the right people and training.

1. SOF Missions

United States Air Force *Doctrine Document 2–7: Special Operations* identifies ten core missions that AFSOC is charged with executing in support of

⁸³ U.S. Special Operations Command, “SOF Truths,” (n.d.), <http://www.socom.mil/default.aspx>

⁸⁴ NATO Special Operations Headquarters, *Special Air Warfare*, 3.

USSOCOM and Secretary of Defense guidance.⁸⁵ Moreover, NSHQ's *Special Air Warfare Manual* presents similar capabilities SOF aviation should be able to perform in support of the principle tasks assigned to NATO SOF.⁸⁶ Of these, three stand out as basic missions that emerging SOF aviation-capable allies should focus their efforts on to combat irregular threats. These three areas are:

1. Specialized Air Mobility
2. Intelligence, Surveillance, and Reconnaissance
3. Precision Aerospace Fires

Figure 7 presents each of these with a definition taken from U.S. doctrine.

| Mission Set | Definition per U.S. AFDD 2-7 and JP 1-02 |
|--|--|
| Specialized Air Mobility | The conduct of rapid, global infiltration, exfiltration, and resupply of personnel, equipment, and materiel using specialized systems and tactics. These missions may be clandestine, low visibility, or overt and through hostile, denied, or politically sensitive airspace using manned or unmanned platforms. |
| Intelligence, Surveillance, and Reconnaissance (ISR) | An activity that synchronizes and integrates the planning and operation of sensors, assets, and processing, exploitation, and dissemination systems in direct support of current and future operations. This is an integrated intelligence and operations function. |
| Precision Aerospace Fires | Provide combatant commanders with an integrated capability to find, fix, track, target, engage, and assess (known in USSOCOM as find, fix, finish) targets using a single weapons system or a combination of systems. Execute close air support, air interdiction, and armed reconnaissance missions with required persistence, connectivity, situational awareness, and target identification, lethality, and survivability in low- to selected high-threat operational environments. |

Figure 7. Primary SOF aviation mission sets and explanations, as defined in FDD 2-7⁸⁷

⁸⁵ U.S. Department of the Air Force, *Air Force Doctrine Document 2-7: Special Operations* (December 16, 2005): 10-15.

⁸⁶ NATO Special Operations Headquarters, *Special Air Warfare*, 5-11.

⁸⁷ U.S. Department of the Air Force, *AFDD 2-7*, 13.

2. Hallmark Qualities of SOF Aircraft

While these three SOF aviation mission sets establish the general capabilities SOF aviation should possess, they do not translate well into actual SOF aircraft requirements or analysis criteria. In order to execute missions in diverse environments and battlefields, there are hallmark qualities that light and medium fixed-wing SOF aircraft should possess. From the early days of SOF aviation in World War II to present-day counterterrorism operations, SOF aircraft have possessed these hallmark qualities, allowing aircrew to better support SOF ground operations. These qualities, derived from readings on historical U.S. SOF operations, U.S. SOF aviation doctrine, and NATO doctrine, will allow an emerging SOF aviation power to support the three SOF aviation mission sets. Figure 8 outlines these qualities as they apply to all SOF aircraft, SOF mobility aircraft, SOF ISR aircraft, and SOF precision aerospace fires aircraft. In subsequent chapters, these qualities will be used, along with other aircraft specifications and cost comparisons, as grading criteria for a range of potential low-cost light and medium-fixed-wing aircraft.

| HALLMARK QUALITIES OF SOF AIRCRAFT | |
|--|--|
| All SOF Aircraft | |
| Day/Night/All Weather Capable (Including Night Vision Device Compatible) | |
| Enhanced Navigation/Communication Capable | |
| Threat Environment Survivable (Level of Defensive Capabilities Dictated by Intended Utilization) | |
| Specialized Air Mobility | |
| Airdrop Capable | |
| Ability to operate in various flight regimes (e.g. high, medium, and low altitude structure) | |
| Austere/Semi-prepared Field Capable | |
| ISR | |
| Provide Persistent Coverage | |
| Conduct any Combination of IMINT/SIGINT/ELINT/COMMINT Gathering | |
| Can be Integrated into Wider ISTAR Network (Inflight Dissemination and Receipt of ISTAR data) | |
| Provide Battlefield C2 and Airspace Deconfliction | |
| Precision Aerospace Fires | |
| Precise Munitions Employment and BDA | |
| Positive ID of Friendly and Enemy Forces Capable | |

Figure 8. Hallmark Qualities of SOF Aviation.

E. SUMMARY

As warfare continues to trend toward irregular adversaries, SOF will continue to be employed to combat them. In order to benefit from the full spectrum of options SOF brings with them, U.S. allies should consider the value of investing in practical SOF aviation components as well. While each nation may differ on what they qualify as SOF aviation, this study recommends that at a minimum aircraft possess numerous, if not all, of the hallmark qualities of SOF aviation. The likely future operating environment, characterized by a distributed, non-contiguous battlespace, will not require every special operations aircraft to possess the full suite of specialized systems found in the U.S.'s AFSOC aircraft. If allies do find themselves in need of such aircraft, they can call on the United States and other partner nations for assistance.

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III. LIGHT-FIXED-WING AIRCRAFT

A. INTRODUCTION

The purpose of this section of the study is to provide an analysis of the costs and benefits associated with developing, procuring, and employing light-fixed-wing aircraft in support of Special Operations Forces (SOF). The examination considers four light-fixed-wing platforms to determine whether they effectively support the Special Operations Core Activities detailed in Chapter II. Specifically, direct action, special reconnaissance, and military assistance are analyzed. These three core activities do not nest exactly into the mold in which the U.S. Joint Forces Command and the U.S. Special Operations Command (USSOCOM) highlighted in their 2010 Joint Operating Concept (JOC) entitled *Irregular Warfare: Countering Irregular Threats v. 2.0*.⁸⁸ The Core Activities examined herein do, however, lend themselves nicely to the competencies of light-fixed-wing aircraft. Through the lens of these three core activities, the operating capabilities of light-fixed-wing aircraft are then surveyed with reference to the primary SOF aviation mission sets as defined in Figure 7.–1.) Specialized air mobility, 2.) Intelligence, surveillance, and reconnaissance (ISR), and 3.) Precision aerospace fires.⁸⁹ Finally, this analysis of alternatives will examine whether a multi-mission aircraft is a good fit to support these mission sets in lieu of fielding multiple single-role platforms.

B. SOF'S CORE ACTIVITIES

Three of the principal task areas with which all SOF are charged are direct action, special reconnaissance, and military assistance. In order to determine how airpower can enable greater mission success rates, this section takes pause to dissect each of these tasks. For an exhaustive list of the missions the U.S. Joint Chiefs of Staff deems “Special Operations Core Activities,” reference Figure

⁸⁸ U.S. Department of Defense, *Irregular Warfare: Countering Irregular Threats v. 2.0*, Joint Operating Concept, 9.

⁸⁹ U.S. Department of the Air Force, *AFDD 2–7*, 13.

6. A description of the three chosen Core Activities follows, as well as rationale for dedicated SOF airpower support. Specifically, this study focuses on the critical mission sets in which emerging SOF aviation-capable establishments should focus efforts in order to combat irregular threats, as defined by the U.S. Department of the Air Force, *Air Force Doctrine Document 2–7*.⁹⁰

1. Specialized Air Mobility
2. Intelligence, Surveillance, and Reconnaissance (ISR)
3. Precision Aerospace Fires

1. Direct Action

Direct action entails short-duration strikes and other small-scale offensive actions conducted as special operations in hostile, denied, or diplomatically sensitive environments. These operations employ specialized military capabilities to seize, destroy, capture, exploit, recover, or damage designated targets. Normally limited in scope and duration, direct action usually incorporates an immediate withdrawal from the planned objective area. Although classically considered close combat, direct action also includes sniping and other standoff attacks by fire delivered or directed by SOF. Standoff attacks are preferred when the target can be damaged or destroyed without close combat. Direct action missions may also involve locating, recovering, and restoring to friendly control selected persons or materiel that are isolated and threatened in sensitive, denied, or contested areas.⁹¹

The diverse requirements of direct actions are greatly enhanced by all three competencies of dedicated light-fixed-wing air support.

⁹⁰ See Figure 7 for a full description of *AFDD 2–7* definitions of SOF mission sets.

⁹¹ U.S. Joint Chiefs of Staff, *JP 3–05*, II-6.

a. Specialized Air Mobility

While assault forces are traditionally inserted by helicopter or make their approach to the objective by vehicle or foot patrol, the correct short takeoff and landing (STOL) aircraft could fill this void. The same holds true for exfiltration of the ground force. As defined in Chapter I, STOL aircraft require less than 1,500 feet of landing area, and in reality, many aircraft reviewed herein need substantially less. Beyond support of ground operations in direct action, aircraft with lift capability can also assist in reconstituting personnel to friendly control after recovery.

b. Intelligence, Surveillance, and Reconnaissance

Direct action missions without the support of ISR became exceptionally rare in the Iraq and Afghanistan conflicts following 9/11. Intelligence, surveillance, and reconnaissance assets normally accomplish the “find and fix” task that precedes any direct action, often providing the “trigger” that launches an assault. During the planning and rehearsal process, ISR aircraft are utilized to corroborate satellite imagery or national-level intelligence. This information is frequently difficult for analysts to decipher, and putting “eyes” overhead in real time assists in putting the virtual puzzle pieces together. In addition to further resolution of the target objective, aircrew can use their subject matter expertise to help devise infiltration and exfiltration routes for the assault team. Then, on infiltration, the now-familiar ISR aircrew is prepared to perform escort duty, advising of any potential threats.

During actions on the objective, ISR is invaluable. At the moment of breach, containing fleeing enemies is a great concern. If positive identification of inhabitants of a compound, for example, is lost, well being of the ground party is at stake. Additionally, over watch, or general cordon-search of the area, allows commandos to focus on their immediate threat without concern for a potential ambush. If a “stack” of aircraft is in support of a direct action, the ISR platform is frequently assigned Tactical Air Controller-Airborne (TAC-A) duties, especially if

the ground-to-air liaison element is too absorbed to control the air assets. An ISR aircraft can also enable effective command and control, both for the ground force commander (GFC) and higher headquarters (HHQ). With their “big picture” of what is unfolding during a direct action and a direct communications link with multiple parties on the ground, the ISR aircrew can keep the GFC’s situation awareness high as well as keep HHQ informed of developments and results of the assault.

In preparation for exfiltration, ISR aircrew can select a rally point for the ground party and suitable helicopter-landing zone (HLZ) if the commandos are to be lifted off target. Furthermore, if the ISR platform is so equipped, infrared illumination of the HLZ allows for a blacked-out arrival, pickup, and departure of the assault force, further facilitating security of the friendly force. Once the ground team is off-target, ISR aircraft can lead the recovery asset(s) out of the non-permissive area.

Finally, following direct action missions, intelligence analysts are often interested in post-operation reflections at the target site. Again, tactical ISR platforms perform this important task to facilitate follow-on special operations efforts.

c. *Precision Aerospace Fires*

A light-fixed-wing aircraft with strike capability is also useful in direct action. During the infiltration phase of the operation, assaulters can be provided an armed escort, regardless of their mode of transportation (helicopter, vehicle, or foot patrol). Additionally, target preparation/softening the target area can be accomplished with a light-strike platform. While on the objective, close air support is often required to subdue enemy hostility. Finally, clearing an exfiltration route with preemptive strikes and/or suppression fire is a valid means of paving the way for the ground force’s safe return to base.

2. Special Reconnaissance

Special reconnaissance entails missions conducted as special operations in hostile, denied, or diplomatically sensitive environments to collect or verify information of strategic or operational significance, employing military capabilities not normally found in conventional forces. These actions provide an additive collection capability for commanders and supplement other conventional reconnaissance and surveillance actions. Special reconnaissance includes target acquisition, area assessment, and post-strike reconnaissance, and may be accomplished by air, land, or maritime assets.⁹²

a. *Precision Aerospace Fires*

Strike platforms can be useful in special reconnaissance missions, as they provide for armed escort of either ground forces executing a mission or unarmed ISR aircraft enroute to/from an objective as well as while on target.

b. *Intelligence, Surveillance, and Reconnaissance*

Special reconnaissance missions employ the most fundamental capabilities of ISR aircraft. Intelligence, surveillance, and reconnaissance platforms that are dedicated to SOF can offer unique and specialized capabilities not available to conventional forces. These capabilities are afforded by SOF's exclusive relationship with interagency partners and the technology these organizations bring to the fight. This collaborative effort across the spectrum of defense and security agencies acts as a force multiplier not realized at the general purpose forces level. Light-fixed-wing aircraft, in particular, possess unique characteristics rarely enjoyed by other military assets. A few examples include civilian paint schemes, low noise and visual signature, and widely proliferated aircraft types. These qualities, along with a typically small aircrew requirement and logistics trail make the small footprint of light-fixed-wing aircraft ideal for providing dedicated and tailored ISR support to SOF. These attributes

⁹² U.S. Joint Chiefs of Staff, *JP 3-05*, II-7.

are pivotal when operating in denied or diplomatically sensitive areas of responsibility.

3. Military Assistance

Military assistance is not represented in the U.S. Joint Forces Command and U.S. Special Operations Command 2010 JOC entitled *Irregular Warfare: Countering Irregular Threats v. 2.0*. However, this Core Activity was chosen for analysis due to its utility beyond the ambitions of the United States. In other words, military assistance encompasses a broader spectrum in which to employ SOF, which may be more aligned with another nation/coalition's interests. The *Initial Capabilities Document for NATO Special Operations Air Warfare Center*, published by USSOCOM, is very compelling in specifying that, "military assistance is a broad SOF Principle Task [that] goes well beyond training and advising and involves combined combat operations."⁹³ While this is a valid assessment, the document provides no further detail on what precisely military assistance encompasses. For the purposes of this study, military assistance is defined as a combination of foreign internal defense (FID) and security force assistance (SFA). The primary roles in FID are to assess, train, advise, and assist host nation military and paramilitary forces with activities that require the unique capabilities of SOF.⁹⁴ The goal is to enable host nation forces to maintain internal stability, to counter subversion and violence in their country, and to address the causes of instability. Similarly, SFA consists of organizing, training, equipping, rebuilding, and advising various components of foreign security forces.⁹⁵ The main difference between FID and SFA is that the latter helps prepare foreign security forces to defend against *external* threats.

⁹³ U.S. Special Operations Command, *Initial Capabilities Document for NATO Special Operations Air Warfare Center*, i, February 16, 2012.

⁹⁴ U.S. Joint Chiefs of Staff, *Joint Publication 3-22: Foreign Internal Defense*, GL-7, retrieved March 23, 2012, http://www.dtic.mil/doctrine/new_pubs/jp3_22.pdf.

⁹⁵ U.S. Joint Chiefs of Staff, *JP 3-22*, I-16.

Much like Direct Attack missions, all three competencies of light-fixed-wing aircraft (specialized air mobility, ISR, and precision aerospace fires) provide support to the requirements of military assistance. The capabilities with which a partner nation requires assistance will dictate the type of light-fixed-wing aircraft to be employed. Any of the unique mission sets described above could be offered “a la carte” and packaged together for the partner nation of interest. While a multi-mission platform would be a good fit for any Core Activity of SOF, the requirements of military assistance scream for this capability.

C. AIRCRAFT CANDIDATES

There is considerable literature on the benefits of light-fixed-wing aircraft (e.g., cost, simplicity, efficiency). There are also many manufacturers worldwide that supply light-fixed-wing aircraft to individuals, businesses, and militaries. While some small aircraft builders are renowned for providing excellent products, a nation or coalition that warrants dedicated SOF aircraft will likely favor a larger aircraft manufacturer. An organization that demands special operations airpower will require aircraft that can be produced rapidly and in mass, possess readily available replacement parts, and have technicians who are familiar with the aircraft systems. For this reason, the focus of this study and platforms for examination has been narrowed down in scope. The light-fixed-wing aircraft herein represent a small sampling of the many viable options on today’s market. They have a few traits in common, all of which are important considerations for a SOF air component. Each of these platforms has proven itself worthy, both in the private sector as well as in military/security operations. In fact, the U.S. Air Force either currently or has in its history operated three of the four platforms as utility aircraft in combat (AU-23A, aka Porter; U-27, aka Caravan; UV-18B, aka Twin Otter).⁹⁶ The only platform not employed by the U.S. is the Defender, which is operated by over thirty other countries worldwide. Included in this extensive list is the United Kingdom, whose Army Air Corps has combat employed the Defender

⁹⁶ Global Security, “Past Military Cargo Aircraft,” retrieved October 20, 2012, <http://www.globalsecurity.org/military/systems/aircraft/u-27.htm>.

with great success in Northern Ireland and Iraq.⁹⁷ All of these aircraft are prevalent across the globe, and do not overtly suggest a military presence. In fact, each aircraft was initially manufactured for the civilian sector, and all four continue to be marketed to the general public.



Figure 9. Cessna C-208 Caravan with Cargo Pod



Figure 10. Pilatus PC-6 Porter

⁹⁷ Army Technology, "Britten-Norman BN-2T-4S Defender 4000 Surveillance Aircraft, United Kingdom," *Key Data*, retrieved March 28, 2011, <http://www.army-technology.com/projects/defender-4000/>.



Figure 11. Viking Air DHC-6-400 Twin Otter



Figure 12. Britten-Norman BN2T-4S Defender

1. Multi-mission Light-Fixed-Wing Aircraft

A dedicated SOF air component will likely resemble the U.S. Air Force Special Operations Command (AFSOC) in some of its aircraft requirements. As of mid-2012, AFSOC was in the process of determining what type of FID aircraft

to field in order to answer the demand signal of worldwide partner nations. Desired mission set configurations are listed in Table 2.

| Desired Configurations for AFSOC FID Aircraft |
|---|
| STOL, day/night low level infiltration/exfiltration (personnel and cargo) |
| Airdrop of personnel and small pallets/bundles |
| ISR/over watch/Command and Control |
| Casualty Evacuation, Medical Evacuation |
| Counter-Narcotics |
| Border Patrol/Maritime Operations |
| Humanitarian Assistance and Disaster Relief |

Table 2. Desired Configurations for AFSOC FID Aircraft⁹⁸

The list of requirements for this aircraft is lengthy; it will be the quintessential multi-mission platform. In fact, the *U.S. Air Force Force Structure Changes: Sustaining Readiness and Modernizing the Total Force* document addresses pending force structure changes and calls for an increased emphasis on multi-mission platforms as a cost saving tool. The document states, "... multi-role platforms provide more utility across the range of the potential missions for which we are directed" and goes on to recommend the U.S. Air Force "retire all aircraft of a specific type, allowing us to also divest the unique training and logistic support structure for that aircraft."⁹⁹ All said, the fact that AFSOC is seeking to field a platform with such robust capabilities is no coincidence. Likewise, in adhering to the directive of smart defense, this is the type of initiative that will gain efficiencies and pay huge dividends for any military outfit.

⁹⁸ U.S. Air Force Special Operations Command, *Capability Production Document for Light Twin-Engine Aircraft to Support Aviation Foreign Internal Defense*, November 2011, 16.

⁹⁹ U.S. Department of the Air Force, *USAF Force Structure Changes*, 3.

D. MEASURES OF ANALYSIS

1. Cost

a. Acquisition Cost

The four aircraft chosen for analysis herein have remarkably similar acquisition costs. Aside from the significantly larger Twin Otter, the difference in aircraft cost is at most \$300,000. This initial fiscal commitment is important in the selection process, especially considering most organizations will require multiple platforms to support SOF activities. A single air asset is hardly capable of meeting the needs of most special operations, thus based upon the organization's fleet requirement, price gaps between potential platforms will be compounded. An additional consideration in the acquisitions process is the price basis per aircraft, which can vary widely depending on the number of orders placed. Absolute procurement costs of the four light-fixed-wing aircraft examined are detailed in Table 3.

| Aircraft | Cost | Source |
|------------------------|-----------------------|-----------------|
| Cessna 208 | \$2.3M ¹⁰⁰ | Cessna Aircraft |
| Pilatus PC-6 | \$2.0M ¹⁰¹ | Flight Global |
| Britten-Norman BN2T-4S | \$2.1M ¹⁰² | Jane's IHS |
| Viking Air DHC-6 | \$3.6M ¹⁰³ | Aviation Today |

Table 3. Select Light-Fixed-Wing Aircraft Acquisition Cost

¹⁰⁰ Cost data acquired from <http://www.cessna.com>, October 15, 2012.

¹⁰¹ Cost data acquired from <http://www.flightglobal.com> in 2010 dollars; converted to 2012 dollars at <http://www.usinflationcalculator.com>, October 16, 2012.

¹⁰² Cost data acquired from <http://www.janes.ihs.com> in 2008 dollars; converted to 2012 dollars at <http://www.usinflationcalculator.com>, October 16, 2012.

¹⁰³ Cost data acquired from <http://www.aviationtoday.com> in 2007 dollars; converted to 2012 dollars at <http://www.usinflationcalculator.com>, October 12, 2012.

b. Cost Per Flying Hour

With the prelude of Cost Per Flying Hour (CPFH) provided in Chapter I, a summation of aircraft-specific CPFH follows. For reference, the U.S. Air Force CV-22 Osprey costs \$13,840 per hour to operate. This is the costliest aircraft in AFSOC's inventory. At a fraction of the CV-22's cost, the UH-1N Huey costs just \$2,509 per hour to operate.¹⁰⁴ The CPFH numbers presented below are *Contracted* CPFH, or CCPFH. They must not be confused with that of the CV-22, a traditional "blue suit" maintained platform. There are many different factors considered when aircraft maintenance contracts are introduced. For example, the CCPFH is dependent on numerous issues not included in standard U.S. Air Force CPFH calculations, such as the number of operating locations, the degree of contract maintenance and supply management services required, personnel costs, etc.

The following three platforms are light-fixed-wing aircraft that AFSOC procured within the past six years. The mission specifics of the aircraft are discussed in greater detail in a subsequent section, but the unique thing of the platforms is the fact they are serviced and maintained by Contract Logistics Support (CLS), rather than "blue suit" technicians. In the case of these programs, contractors are required to provide for an 80 percent mission-capable rate. The costs associated with aircraft upkeep do not include aircraft acquisition costs or aircrew expenses. The figures do, however, include:

1. Fuel cost
2. Aircraft parts
3. Maintenance labor
4. Miscellaneous expenses

¹⁰⁴ Evans Glausier, e-mail communication to authors, March 22, 2012.

| Aircraft | Hours | CLS Cost | Contract Cost Per Flying Hour |
|----------|--------|----------|-------------------------------|
| U-28 | 73,200 | \$112.8M | \$1,540 |
| PC-12 | 11,300 | \$16.4M | \$1,558 |
| C-145 | 7,700 | \$20.8M | \$2,549 |

Table 4. AFSOC Light-Fixed-Wing Annual CLS Cost Per Flying Hour¹⁰⁵

In order to provide a more realistic cost of ownership, aircraft unit price and projected lifespan need to be considered. Table 5 accounts for these factors:

| Aircraft | A/C Price | Lifespan | Cost per Year per A/C | A/C Cost Per Flying Hour |
|----------|-----------|----------|-----------------------|--------------------------|
| U-28 | \$15M | 15 Years | \$1.0M | \$355 |
| PC-12 | \$6M | 15 Years | \$0.4M | \$354 |
| C-145 | \$10M | 15 Years | \$0.67M | \$571 |

Table 5. AFSOC Light-Fixed-Wing Aircraft Cost Per Flying Hour¹⁰⁶

Finally, combining the data from the two previous tables paints a more complete picture of the realistic cost of operating these light-fixed-wing aircraft:

¹⁰⁵ All of the figures listed are notional, and are based on the U.S. Special Operations Command "FY11 Contract Cost Per Flying Hour Data" briefing dated February 27, 2012.

¹⁰⁶ All of the figures listed are notional, and are based on the U.S. Special Operations Command "FY11 Contract Cost Per Flying Hour Data" briefing dated February 27, 2012.

| Aircraft | CLS | Aircraft | Total Cost per Flying Hour |
|----------|---------|----------|----------------------------|
| U-28 | \$1,540 | \$355 | \$1,895 |
| PC-12 | \$1,558 | \$354 | \$1,912 |
| C-145 | \$2,549 | \$571 | \$3,120 |

Table 6. AFSOC Light-Fixed-Wing *Total Cost Per Flying Hour*¹⁰⁷

While these particular AFSOC aircraft may or may not be a good fit for the situational mission requirements of all organizations seeking SOF aircraft, the cost data presented above represent the approximate price range to be expected for potential light-fixed-wing operators.

Another model for determining CPFH is one developed by Conklin and de Decker, a U.S. based general aviation consulting firm. The cost information below is the total aircraft variable cost an operator can expect to incur per hour during aircraft operation. Variable costs include the following, and are shown in Table 7.

1. Fuel cost
2. Fuel burn
3. Fuel additives
4. Aircraft parts
5. Maintenance labor
6. Landing and parking fees
7. Crew expenses

¹⁰⁷ All of the figures listed are notional, and are based on the U.S. Special Operations Command "FY11 Contract Cost Per Flying Hour Data" briefing dated February 27, 2012.

| Aircraft | Variable Cost Per Flying Hour |
|---------------------------------|-------------------------------|
| Cessna 208 Caravan | \$614 |
| Pilatus PC-6 Porter | \$557 |
| Britten-Norman BN2T-4S Defender | \$805 |
| Viking Air DHC-6 Twin Otter | \$1,151 |

Table 7. General Aviation Variable Cost Per Flying Hour¹⁰⁸

When extrapolated over an expected lifespan of 15 years, the CPFH among these four aircraft is comparable, with the exception of the considerably more expensive Twin Otter (see Figure 13).

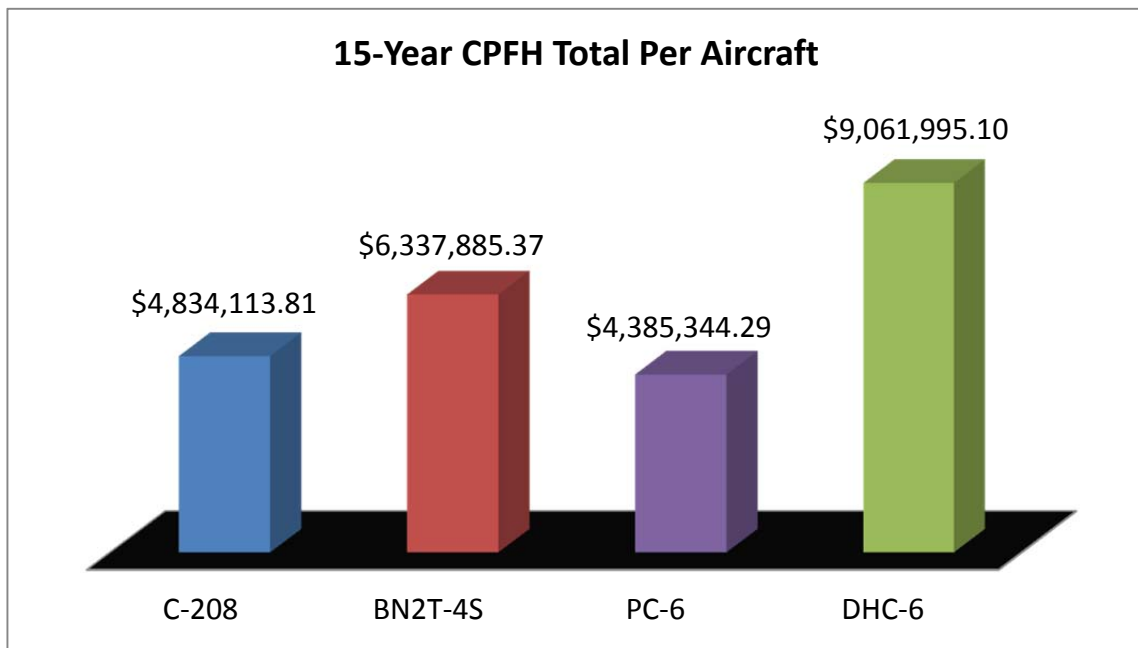


Figure 13. 15-Year CPFH Total Per Aircraft

¹⁰⁸ Conklin and de Decker, "Aircraft Cost Summary," accessed March 22, 2012, <http://www.conklindd.com/CDALibrary/ACCostSummary.aspx>.

There is a wide variance of CPFH rates presented above, from the seemingly inexpensive PC-6 Porter (\$557/hour) to the more costly C-145 Skytruck (\$3,120/hour). Further analysis is recommended to determine the most appropriate costing model, based upon the organization's specific requirements.

2. Mission Effectiveness

a. Specifications

The following comparison offers four impressive light-fixed-wing aircraft options, ranging from the 6,173-pound Pilatus PC-6 Porter to the top of the light-fixed-wing weight threshold Viking Air DHC-6–400 Twin Otter. There are many specifications and data in Tables 8 and 9, ranging from interior dimensions to takeoff and landing distances.

| Aircraft | Seats (exec) | Cabin Volume (cu.ft) | Cabin Height (ft) | Cargo (interior) (cu.ft) | Cargo (exterior) (cu.ft) | Max Useful Load (lbs) |
|------------------------|--------------|----------------------|-------------------|--------------------------|--------------------------|-----------------------|
| C-208 ¹⁰⁹ | 9 | 254 | 4.5 | 33 | 84 | 4105 |
| BN2T-4S ¹¹⁰ | 9 | 327 | 4.2 | 105 | - | 1598 |
| PC-6 ¹¹¹ | 7 | 117 | 3.9 | 106 | - | 2381 |
| DHC-6 ¹¹² | 10 | 384 | 4.9 | 88 | 38 | 2500 |

Table 8. Select Light-Fixed-Wing Aircraft Specifications¹¹³

¹⁰⁹ Cessna Aircraft Company, *Pilot Information Manual*, "Cessna 208 Caravan (with optional cargo pod) Performance Section," retrieved March 25, 2012, http://textron.vo.llnwd.net/o25/CES/cessna_aircraft_docs/caravan/grandcaravan/grandcaravan_pim.pdf.

¹¹⁰ Britten-Norman Aircraft Limited, *Defender: More Than Meets the Eye*, retrieved March 25, 2012, <http://www.britten-norman.com/brochures/defender.pdf>.

¹¹¹ Pilatus Aircraft Limited, *PC-6 Turbo Porter: Anywhere, Anytime, in Any Environment*, retrieved March 24, 2012, <http://www.pc-6.com/vPilatus-ProductBrochure.pdf>.

¹¹² Viking Aircraft, *DHC-6/400 Twin Otter Performance at Maximum Weight*, retrieved March 25, 2012, <http://weppi.gtk.fi/aerogeo/en/equipment/dhc6.pdf>.

| Aircraft | MGTOW (lbs) | Max Cruise (ktas) | Max Range @ MGTOw (nm) | Takeoff/Landing Distance (ft) ¹¹⁴ | Takeoff/Landing Ground Roll (ft) ¹¹⁵ |
|------------------------|-------------|-------------------|------------------------|--|---|
| C-208 ¹¹⁶ | 8750 | 175 | 871 | 2500/1740 | 1405/915 |
| BN2T-4S ¹¹⁷ | 8500 | 176 | 861 | 1855/1934 | 1167/1012 |
| PC-6 ¹¹⁸ | 6173 | 125 | 500 | 1444/1043 | 646/417 |
| DHC-6 ¹¹⁹ | 12500 | 182 | 700 | 1940/1500 | 700/515 |

Table 9. Select Light-Fixed-Wing Aircraft Performance Data¹²⁰

Like all procurements, for each benefit of a platform’s capabilities, there is also a cost. For instance, along with the Porter’s outstanding landing ground roll of merely 417 feet comes a dismal cruise airspeed of 125 knots and a range of only 500 nautical miles. Likewise, the Twin Otter’s impressive maximum useful load of 4,105 pounds buys it a takeoff ground roll of 1,405 feet, twice as much as two of the other aircraft analyzed. A simple way to thin the herd of choices is to decide whether a single-engine aircraft is acceptable to the organization and its mission requirements. While there is a lot to be said for the redundancy of a multi-engine aircraft, especially considering the austere terrain in which SOF often maneuver, single-engine aircraft provide a significant amount

¹¹³ Jet Exchange, “Turboprop General Comparison,” retrieved October 16, 2012, www.jet-exchange.com/Files/XL/TurbopropGeneralComparison.xls.

¹¹⁴ This figure represents the total field length required to takeoff or land and clear a fifty-foot obstacle.

¹¹⁵ This figure represents distance over the ground required to accelerate to takeoff airspeed (or distance to stop) in order to meet STOL criteria.

¹¹⁶ Cessna Aircraft, *Pilot Information Manual*, “Cessna 208 Performance” retrieved March 25, 2012, http://textron.vo.llnwd.net/o25/CES/cessna_aircraft_docs/caravan/grandcaravan/grandcaravan_pim.pdf.

¹¹⁷ Britten-Norman, *Defender*.

¹¹⁸ Pilatus Aircraft Limited, *PC-6*.

¹¹⁹ Viking Aircraft, *DHC-6/400 Performance*.

¹²⁰ Jet Exchange, “Turboprop Comparison.”

of “bang for the buck” and today’s single-engine powerplants have a top-notch record of safety.

b. Capabilities

Aircraft dimensions, capacities, and performance data are fundamental in determining the appropriate platform for a particular organization. However, even more important is whether an aircraft can effectively support a given mission set. Specifically, this portion of the study investigates individual platforms and scores them against a set of “hallmark qualities” that SOF aviation demands. These qualities allow for an objective measurement of each aircraft candidate’s capabilities. The traits were adopted from the 2008 study conducted by the NATO Special Operations Coordination Centre (NSCC), in which aircraft criteria were outlined.¹²¹ The exhaustive list stipulated by NSCC, found at Appendix A, was tailored to suit the purposes of this study—light (and medium) fixed wing SOF aircraft. In Tables 10, 11, 12, and 13 a “Yes” score implies that the aircraft manufacturer offers the capability. A “No” score implies that the capability is not a factory option for the aircraft. Given proper resources and time, in nearly all cases the aircraft examined can be modified to perform any of these hallmark qualities. Therefore, a binary scoring system was chosen in an effort to maintain maximum objectivity. By scoring aircraft in this manner, the study implies that no one quality is more valuable than another. In utilizing this study, organizations may determine that their interests value certain traits more than others, and should weight those traits accordingly.

There are three qualities that *all* SOF aircraft must possess. It is imperative that this type of aircraft can be safely maneuvered in instrument meteorological conditions in low illumination as well as daylight-visual meteorological conditions. In order to effectively support SOF activities, adverse flight conditions must not degrade mission capability. Weather radar, de-icing

¹²¹ NATO Special Operations Coordination Centre, *Special Operations Forces Study*, Annex C.

equipment, and night vision goggle-compatible cockpits were among the considerations of this Hallmark Quality. As shown in Table 10, all subject aircraft are available from the factory with suitable equipment.

Advanced, stand-alone cockpit navigation tools are essential in the austere environments in which special operations often occur. An example of this type of equipment is a satellite-based navigation system, independent of ground-based navigational aids. Systems such as this allow for area navigation (RNAV) and self-contained instrument approaches. Aircraft with RNAV capability can be flown on any desired flight path within the coverage of ground- or spaced-based navigation aids, within the limits of the capability of the self-contained systems, or a combination of both capabilities.¹²² As such, RNAV aircraft have better access and flexibility for point-to-point operations. An effective, reliable, and user-compatible communications suite is not negotiable for a special operations aircraft. To the point, poor communications between air and ground operators is a common thread in degraded or failed military missions. Equipment such as both line-of-sight and beyond line-of-sight (e.g., satellite) radios and secure voice capability were considered here. With the exception of the Cessna 208 Caravan, all subject aircraft are factory-ready with this Hallmark Quality. The lack of an advanced communications suite on the Caravan is the only thing that kept it from scoring in this category.¹²³

The final hallmark quality that SOF aircraft must possess is aircraft survivability equipment (ASE). Examples of ASE include missile-warning systems that deploy flares and/or chaff in defense of the aircraft and lead blankets that protect the aircrew and passengers/equipment from small arms fire. None of the subject aircraft are factory-equipped with ASE. The lack of ASE on these

¹²² U.S. Federal Aviation Administration, *Fact Sheet—NextGen Goal: Performance-Based Navigation*, 24 April 2009, retrieved October 16, 2012, http://www.faa.gov/news/fact_sheetsnews_story.cfm?newsid=8768.

¹²³ Cessna Aircraft Company, *Grand Caravan Optional Equipment Guide—Effective for Aircraft to be Delivered in 2012*, retrieved October 18, 2012, http://textron.vo.llnwd.net/o25/CES/cessna_aircraft_docs/caravan/grandcaravan/grandcaravan_og.pdf.

platforms is not abnormal, however. Regional threat assessments largely dictate the level of ASE required for aircraft buyers, and a “standard configuration” offered by an aircraft maker would not make good business sense. Aircraft scoring on these hallmark qualities of *all* SOF Aircraft is shown in Table 10.

| Hallmark Qualities of ALL SOF Aircraft | | | | |
|---|--------------|-------------|-------------|--------------|
| Quality | C-208 | BN2T | PC-6 | DHC-6 |
| Day/Night/All Weather Capable | 1 | 1 | 1 | 1 |
| Enhanced Nav/Communication Capable | 0 | 1 | 1 | 1 |
| Threat Environment Survivable (Defensive Capabilities Dictated by Intended Utilization) | 0 | 0 | 0 | 0 |
| Score Total | 1 | 2 | 2 | 2 |

Table 10. Hallmark Qualities of ALL SOF Aircraft (Yes=1 point & No=0 points)

As Figure 7 (Chapter II) defines, specialized air mobility encompasses flight operations in diverse environments (e.g., hostile, denied, politically sensitive), and under varied circumstances (e.g., clandestine, low visibility, overt). There are three hallmark qualities that stand out among SOF aircraft. First of all, these aircraft must be capable of taking off and landing on multiple surfaces. Landing surfaces considered were dirt, packed-sand, grass, and gravel, as these are examples of landing zones encountered in support of special operations. As shown in Table 11, all subject aircraft scored well in this category, with options such as low-pressure tires, twin-caliper disc brakes, and reinforced undercarriages.¹²⁴

Next, the ability to operate in different flight regimes is important for special operations support. For example, mission requirements may dictate a high-altitude over flight of politically sensitive areas and subsequent descent to a low-level infiltration of assaulters, followed by a medium-altitude over watch assignment. Again, all of the aircraft examined herein scored well in this

¹²⁴ Pilatus Aircraft Limited, PC-6.

category. While none of the platforms are pressurized, they all have an operational ceiling of 25,000 feet, ample for aircraft in the light-fixed-wing category. Likewise, with their low stall speeds, these aircraft perform exceptionally well in the low altitude environment.

The final hallmark quality of specialized air mobility is the capability to airdrop personnel and equipment. Three out of four aircraft examined are airdrop-ready upon leaving the production floor. From the trap door in the Pilatus PC-6 Porter¹²⁵ to the sliding doors of the Cessna C-208 Caravan¹²⁶ and Viking Air DHC-6 Twin Otter,¹²⁷ these platforms are well suited for airdrop. The only exception, as shown in Table 11, is the Britten-Norman BN2T Defender. It is built with traditional automobile-like doors for cockpit access and cargo storage.¹²⁸

| Hallmark Qualities of Specialized Air Mobility | | | | |
|---|--------------|-------------|-------------|--------------|
| Quality | C-208 | BN2T | PC-6 | DHC-6 |
| Austere/Semi-prepared Field Capable | 1 | 1 | 1 | 1 |
| Ability to operate in various flight regimes (high, medium, and low altitude structure) | 1 | 1 | 1 | 1 |
| Airdrop Capable | 1 | 0 | 1 | 1 |
| Score Total | 3 | 2 | 3 | 3 |

Table 11. Hallmark Qualities of Spec. Air Mobility (Yes=1 point & No=0 points)

Light-fixed-wing aircraft have become a popular choice in recent years for the ISR mission. This type of aircraft is typically fairly simple to operate at altitude, which helps to make crewmember resources available for tasks beyond traditional “stick and rudder” requirements. To be an effective ISR

¹²⁵ Pilatus Aircraft Limited, *PC-6*.

¹²⁶ Cessna Aircraft, *Grand Caravan Optional Equipment*.

¹²⁷ Viking Aircraft, “Twin Otter Series 400: Versatility That Works,” retrieved October 14, 2012, <http://www.vikingair.com/uploadedFiles/400S%20Multi-Page.pdf>.

¹²⁸ Britten-Norman Aircraft Limited, “Defender General Information,” retrieved October 17, 2012, <http://www.britten-norman.com/defender/>.

platform, a commitment to target saturation is pivotal—this boils down to time on station. For the purposes of this study, “Persistent Coverage” is defined as endurance to remain on target for at least six hours unrefueled. As shown in Table 12, all four aircraft met or exceeded the standard. From the Caravan’s six and one-half hours flight time¹²⁹ to the Twin Otter’s lengthy 12.5 hours of endurance (with Guardian 400 factory modification),¹³⁰ the aircraft are well suited to meet the intent of this Hallmark Quality.

Another attractive aspect of light-fixed-wing aircraft for ISR is their compatibility with a wide range of commercially available off-the-shelf (COTS) sensors. These widely available electro-optical and infrared imaging turrets are natural solutions to the surveillance problem. While Cessna does not offer a sensor package on the Caravan,¹³¹ the three other manufacturers examined produce surveillance-ready aircraft.

In addition to stand-alone surveillance capability, integration into the wider network of ISR platforms is vital to the analysis of intelligence collection. In other words, if an aircraft’s imagery feed is not transmitted to the appropriate agency in a timely manner or if an aircraft cannot receive critical updates from another airborne asset, mission degradation is probable. While the “Special Mission” Porter and Viking Air’s “Guardian” are equipped with robust sensor suites, according to Britten-Norman’s Government Business Director, only the Defender can be fully integrated into the wider ISR network upon leaving the factory floor.¹³²

Likewise, as shown in Table 12, the Defender is the sole aircraft in this group that has a communications suite robust enough to provide command

¹²⁹ Cessna Aircraft Company, “Endurance Profile with Cargo Pod Installed,” *C-208B Pilot Information Manual*, retrieved 16 October 2012, http://textron.vo.llnwd.net/o25/CES/cessna_aircraft_docs/caravan/grandcaravan/grandcaravan_pi_m.pdf.

¹³⁰ Viking Aircraft, “Twin Otter Series 400.”

¹³¹ Cessna Aircraft, *Grand Caravan Optional Equipment*.

¹³² Gerald Smith, e-mail communication to the authors, October 8, 2012.

and control of the battle space and effectively deconflict airspace.¹³³ In addition to multiple radios, tools that enhance aircrew situation awareness (e.g., cockpit displays, data exchange networks) are key to this Hallmark Quality.

| Hallmark Qualities of Intelligence, Surveillance, and Reconnaissance | | | | |
|---|--------------|-------------|-------------|--------------|
| Quality | C-208 | BN2T | PC-6 | DHC-6 |
| Provide Persistent Coverage | 1 | 1 | 1 | 1 |
| Conduct any Combination of IMINT/SIGINT/ELINT/COMINT Gathering | 0 | 1 | 1 | 1 |
| Can be Integrated into Wider ISR Network (Inflight Dissemination and Receipt of ISR data) | 0 | 1 | 0 | 0 |
| Provide Battlefield C2 and Airspace Deconfliction | 0 | 1 | 0 | 0 |
| Score Total | 1 | 4 | 2 | 2 |

Table 12. Hallmark Qualities of ISR (Yes=1 point & No=0 points)

The final mission set that a SOF aviation-capable nation should be able to perform is precision aerospace fires. Referencing Figure 7 (Chapter II), this SOF mission is based on providing combatant commanders with an integrated capability to find, fix, track, target, engage, and assess targets. The first four tasks involved in providing this capability are readily accomplished with the sensor suites detailed above. However, none of the aircraft investigated are munitions-ready from the manufacturer. While all of these aircraft can be (and in some cases, have been) weaponized, none can employ munitions and provide battle damage assessment (BDA) upon procurement.

The second quality that complements precision aerospace fires is the acquisition and maintenance of positive identification of both friendly and enemy ground forces. The main ingredient here is an aircraft equipped with a multispectral imaging turret and capable tracking mechanism. As described

¹³³ Gerald Smith, e-mail communication to the authors, October 8, 2012.

above, and shown in Table 13, all subject aircraft except the Caravan possess this capability direct from the manufacturer.¹³⁴

| Hallmark Qualities of Precision Aerospace Fires | | | | |
|--|--------------|-------------|-------------|--------------|
| Quality | C-208 | BN2T | PC-6 | DHC-6 |
| Precise Munitions Employment/BDA Capable | 0 | 0 | 0 | 0 |
| Positive ID of Friendly/Enemy Forces Capable | 0 | 1 | 1 | 1 |
| Score Total | 0 | 1 | 1 | 1 |

Table 13. Hallmark Qual. of Prec. Aerospace Fires (Yes=1 point, No=0 points)

E. AIRCRAFT AVAILABILITY

All of these aircraft (and many other similarly capable platforms) are widely employed across the globe, both in the general aviation sector as well as in military/security organizations. This readily available aspect is important for the aggressive level of ambition in fielding aircraft that is traditionally associated with SOF enterprises. Additionally, there are many companies that specialize in modifying and militarizing aircraft (e.g., Alliant Techsystems and Sierra Nevada Corporation). Businesses like this utilize both commercially available and proprietary products for modification, and often outfit aircraft with carry-on/carry-off (COCO) systems. A light-fixed-wing aircraft with COCO capabilities that can be appropriately outfitted to suit its user would be a remarkable force multiplier for any SOF organization—a multi-mission aircraft with multiple configurations.

One option that this study does not address is the alternative of acquiring excess defense articles rather than new acquisitions to fill the void of organic air support for SOF. Further research is required to exhaust all efforts of this prospect. However, there are literally thousands of aircraft in preservation at the 309th Aerospace Maintenance and Regeneration Group (AMARG), located at

¹³⁴ Cessna Aircraft, *Grand Caravan Optional Equipment*.

Davis-Monthan Air Force Base, AZ. For example, as of December 2011, the U.S. Department of State had a fleet of at least four Beechcraft C-12B King Airs in storage at AMARG.¹³⁵ A procurement such as this, while small in numbers, could pacify the immediate need for air support and buy a SOF organization time to fully assess the long term requirements. Furthermore, the projected mothballing of U.S. military aircraft over the next several years is a promising acquisition option for other would-be SOF-capable air components. Finally, a survey of all coalition partners or allies, for example, could reveal additional light-fixed-wing aircraft in the category of excess defense articles.

F. RECENT LIGHT-FIXED-WING SUCCESSES

1. U-28

The U.S. Special Operations Command (USSOCOM) has fielded two well-regarded SOF aircraft programs within the past seven years. To answer the call for an immediate need for Tactical ISR to support special mission units, USSOCOM began a rapid fielding initiative in 2005. By the summer of 2006, the first U-28s were delivered to Hurlburt Field, FL, and the aircraft have been forward deployed ever since. The expeditious manner in which these aircraft began shaping the battlefield was unprecedented. An acquisition of this caliber is typically a multi-year process, while the selection, purchase, modifications, and testing of the U-28 was executed inside of one year. This model is one in which other organizations can mirror in their quest for SOF-capable air support. Airmen of the newly reactivated 319th Special Operations Squadron of AFSOC were charged with employing the modified Pilatus PC-12 aircraft in support of global pursuit efforts to curb extremist terrorist networks. The U-28 provides a manned light-fixed-wing, on-call/surge capability for improved tactical airborne intelligence, surveillance, and reconnaissance. The U-28 fleet evolved from COTS aircraft, and were modified with communications gear, aircraft survivability

¹³⁵ U.S. Department of State, "Department of State Aircraft Stored at the 309th Aerospace Maintenance and Regeneration Group," December 9, 2011.

equipment, electro-optical sensors, and advanced navigation systems. The advanced communications suite is “capable of establishing DoD/NATO data-links, full-motion video, data, and voice communications.”¹³⁶ The U-28 has shown outstanding reliability and performance under maintenance provided by contractor logistics support, and like the four aircraft examined in this study, it is certified to operate from short and semi-prepared airfields.

When USSOCOM resolved to purchase PC-12s to overcome the shortfall in ISR capability, the program of record called for six aircraft. However, after only one year on the battlefield the decision was made to procure additional aircraft. The operational successes and overwhelming feedback from various users prompted USSOCOM to once again act quickly. Within months, additional U-28s were showing up on the ramps of airfields worldwide, and by 2010 there were 22 mission aircraft and four PC-12 trainers. In March 2012, USSOCOM approved the transfer and modification of an additional 10 PC-12s from within AFSOC, which will bring the total number of mission aircraft to 32 (plus five PC-12 trainers).¹³⁷ To complement the sharp increase in equipment, the number of U-28 aircrew has also blossomed. By 2010, AFSOC activated a new operational squadron (34th Special Operations Squadron) to house half of what had become a force structure of nearly 300 Airmen. In its first year of operations, the 34th Special Operations Squadron flew 4,476 deployed sorties for a total of 24,618 combat flight hours – 67.4 hours per day. In conjunction with the 319th Special Operations Squadron, they enabled 465 EKIA (enemy killed in action) and the capture of 1,151 detainees, and targeted 253 High Value Individuals.¹³⁸ The manned ISR capability that the U-28 program provides to the joint SOF community is unparalleled, and its unique role is pivotal to the U.S. National Security Strategy to defend against violent extremist terrorism.

¹³⁶ U.S. Department of the Air Force, “U-28A Factsheet,” retrieved October 17, 2012, <http://www.af.mil/information/factsheets/factsheet.asp?id=19315>.

¹³⁷ Bruce Kingsbury, e-mail communication to the author, October 17, 2012.

¹³⁸ Andrew Jett, e-mail communication to the author, November 5, 2012.

Over the past six years of U-28 operations, there have been multiple block upgrades to the aircraft. In order to stay in tune with technological advances, spiral developments of the aircraft equipment have been many. While most weapon systems go years between block upgrades, the U-28 has averaged one major overhaul per year since inception.¹³⁹ The enduring fiscal requirements associated with a platform such as the highly technical U-28 must be considered when an organization considers procurement of a fleet of SOF-capable aircraft.

2. Nonstandard Aviation (NSAv)

The second program that has made a significant impact on worldwide SOF efforts is AFSOC's Nonstandard Aviation (NSAv) enterprise. To answer the urgent call for dedicated air support to small, detached teams, AFSOC took delivery of its first light-fixed-wing aircraft in January 2008. Until now, small operational detachments were using contract air to get to and from isolated and remote locations.¹⁴⁰ The NSAv aircraft selected by USSOCOM were to operate in permissive areas, adorned with nondescript paint schemes, allowing the aircrew and their users to "hide in plain sight." The 318th Special Operations Squadron, located at Cannon Air Force Base, New Mexico, was assigned the Pilatus PC-12, and would eventually take delivery of 10 of these aircraft. By the next year, the squadron began operating the Polish-built PZL Mielec M-28 Skytruck,¹⁴¹ which in 2012 was re-designated the C-145.¹⁴² The Skytruck is a virtual workhorse for STOL operations and low-cost, low-altitude airdrop. Finally, the NSAv fleet was rounded out with a medium-fixed-wing aircraft. The German-made Dornier 328,

¹³⁹ Headquarters, U.S. Air Force Special Operations Command, "Background Paper on U-28 Upgrade Cycle," March 13, 2012.

¹⁴⁰ Marc Schanz, "The SOF Makeover," *Air Force Magazine*, Vol. 93, No. 6, June 2010, retrieved October 14, 2012, <http://www.airforce-magazine.com/MagazineArchive/Pages/2010/June%202010/0610SOF.aspx>.

¹⁴¹ The M-28 is largely based on the design of the Soviet Antonov An-28. This aircraft, as with all NSAv platforms, blends in with other non-military aircraft while operating in politically sensitive areas.

¹⁴² Donald Grant, e-mail communication to the authors, September 25, 2012.

re-designated C-146 in 2012,¹⁴³ would be the NSAv community's long-haul platform of choice. As a stopgap during the C-146 acquisition/modification process, several Bombardier Dash 8 (DHC-8-200) aircraft were leased and operated in support of SOF. The option to lease aircraft is a valid consideration for would be special operations air-capable organizations. Depending on the longevity of a proposed program, this alternative might make a better business case than outright aircraft purchase.

The NSAv community has received glowing praise from supported commanders, and has accumulated an impressive set of statistics since its recent inception. Table 14 details the number of sorties, passengers transported, cargo hauled, hours flown, and pounds of airdropped supplies. What is most telling about these figures is that a two ship of PC-12 aircraft was put into service in July 2008, but AFSOC did not deploy any additional assets until October 2010. That said, the data for the C-145 and C-146 represent merely two years of operational employment.

| NSAv Mission Accomplishments (2008–2012) | | | | | |
|---|----------------|---------------|--------------------|--------------------|----------------------|
| Aircraft | Sorties | Pax | Cargo (lbs) | Hours Flown | Airdrop (lbs) |
| PC-12 | 9,532 | 19,032 | 1,885,000 | 15,360 | 0 |
| C-145 | 692 | 2,474 | 503,000 | 2,600 | 667,000 |
| C-146 | 1,069 | 2,144 | 399,000 | 2,559 | 0 |
| Total | 11,293 | 23,650 | 2,787,000 | 20,519 | 667,000 |

Table 14. NSAv Mission Accomplishments (2008–1012)¹⁴⁴

In 2012, USSOCCOM underwent several changes in mission priorities and asset realignments. The NSAv community was affected by these developments, and will be downsized beginning in November 2012. In 2010, the

¹⁴³ Donald Grant, e-mail communication to the authors, September 25, 2012.

¹⁴⁴ Headquarters, U.S. Air Force Special Operations Command, *Cargo & Pax Stats*, retrieved via e-mail September 25, 2012.

Department of Defense Quadrennial Defense Review directed the doubling in size and capability of AFSOC's Combat Aviation Advisory force.¹⁴⁵ One way USSOCOM is complying with this congressional directive is by transferring NSAv C-145s to Duke Field, FL to be flown in support of the Aviation FID mission. Additionally, combatant SOF commanders' seemingly insatiable desire for ISR saturation has led to the USSOCOM order to modify all NSAv PC-12 aircraft to provide increased U-28 capability. Aircraft modifications will begin in 2013, and once complete, AFSOC's NSAv enterprise will be all but dissolved.¹⁴⁶ The 17 Dornier C-146 procurements will be the sole remaining NSAv aircraft. The main take-away from USSOCOM's reorganization of assets is the "modularity" of light-fixed-wing aircraft. Within months, the 10 C-145s will be reconfigured from strictly a SOF-support passenger/cargo-hauling platform to be used in USSOCOM's higher-priority Building Partner-Nation Capacity mission.¹⁴⁷

G. CONCLUSION

The goal of this portion of the study was to provide a survey of the costs and benefits associated with procuring, developing, and employing light-fixed-wing aircraft in direct support of SOF. It was made clear that the employment of SOF, by definition, is the discerning way ahead in the lean times with which many nations across the globe are faced. When appropriately fielded and tasked, an organic light-fixed-wing capability serves as a force multiplier in support of all three major SOF air mission sets. Furthermore, there are efficiencies to be gained by procuring a multi-mission platform in lieu of fielding multiple single-role aircraft. Various capabilities were examined, providing a wide range of alternatives from which to choose. A deliberate analysis of precisely the amount

¹⁴⁵ U.S. Department of Defense, *Quadrennial Defense Review Report*, February 2010, p. 30, retrieved October 18, 2012, http://www.defense.gov/qdr/images/QDR_as_of_12Feb10_1000.pdf.

¹⁴⁶ Timothy Pyeatt, e-mail communication to the authors, October 17, 2012.

¹⁴⁷ Admiral McRaven has made it clear that building partner-nation capacity and mitigating the conditions that make populations susceptible to extremist ideologies is a key element in attaining USSOCOM's first priority: winning the current fight. See "Q and A with Admiral McRaven," *Special Warfare*, April-June 2012, vol. 25, issue 2, http://static.dvidshub.net/media/pubs/pdf_10170.pdf.

of capabilities *desired* versus *required* for an organization's level of ambition would further assist in determining which aircraft(s) to acquire. As greater resolution is gained with respect to the necessary capabilities for a light-fixed-wing platform(s), the large array of alternatives will taper. If an aircraft with said capabilities happens to be inventoried by a nation's alliance member(s) or is in excess defense article supply, pursuing one of these options would discernibly be the recommendation of this research. That said, leaders should resist the temptation to accept readily available aircraft that fail to meet the agreed upon capabilities to support the demands of direct action, special reconnaissance, and military assistance. To settle for lackluster aircraft capabilities would not only undermine SOF's charter, but would also be a disservice to the aircrew, the special operations users, and the strategic objectives of national/multinational organization writ large.

IV. MEDIUM-FIXED-WING AIRCRAFT

A. INTRODUCTION

1. Why Medium-Fixed-Wing Aircraft

In establishing a special operations forces (SOF) aviation capability, allied nations should consider the utility and requirement for a medium-fixed-wing aircraft. As SOF operations continue to grow in necessity, and as allies shift the way they go to combat, a capable and cost effective medium-fixed-wing SOF aircraft could prove invaluable. The primary focus of such an aircraft should be to perform specialized air mobility, but nations should also consider performing intelligence, surveillance, and reconnaissance (ISR) and precision aerospace fires missions. Since the costs and obligations of possessing a fleet of medium-fixed-wing aircraft are greater than that of light-fixed-wing aircraft, nations should consider a crawl-walk-run approach when employing these aircraft for a SOF air group. Prior to investing in aircraft modifications to perform ISR and precision aerospace fires, nations should first master SOF mobility. Figure 14 displays this logical progression of SOF aviation abilities.

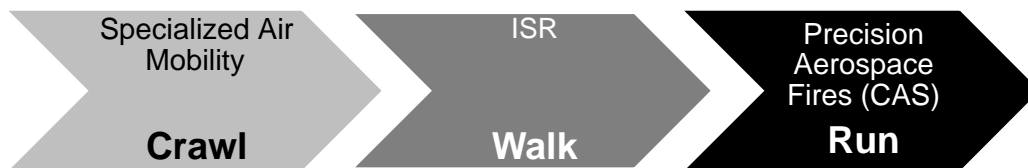


Figure 14. Logical progression for medium-fixed-wing SOF aviation.

The 1st Air Commando Group of the China-Burma-India theater and the Carpetbaggers of the European theater in World War II proved that SOF airlift is essential when conducting unconventional infiltrations and operations behind enemy lines. Without SOF aviation, the unconventional warfare waged by the Office of Strategic Services (OSS) in Europe and Wingate's Chindits in Burma

would have most likely failed.¹⁴⁸ The importance of specialized air mobility is still appreciated in current times. The North Atlantic Treaty Organization (NATO) SOF Headquarters (NSHQ) echoes this importance in their *Special Air Warfare Manual*. The manual states, “The primary mission of special operations air forces is enhanced air mobility—specialized air transport activities via fixed-wing, rotary-wing, or tilt-rotor aircraft.”¹⁴⁹ U.S. Air Force doctrine goes further to address the need for Specialized Air Mobility:

The AFSOF mobility mission area includes the rapid global airlift of personnel and equipment through hostile airspace to conduct operations and to enable air mobility across the range of military operation. AFSOF deployment readiness and unique training contribute to their constant readiness status and to their ability to quickly respond. They often are the first forces to deploy on a global scale. AFSOF capabilities accommodate all operational and physical environments—especially conditions of adverse weather, darkness, and denied territory. Operations may be conducted with a single aircraft or as part of a larger force package and are normally conducted during one period of darkness.¹⁵⁰

2. Multi-Mission Considerations for Medium Aircraft

If nations procure medium-fixed-wing aircraft for SOF utilization there are opportunities for them to further their capabilities by expanding to multi-mission aircraft, capable of performing all three SOF aviation missions—(1) specialized air mobility, (2) ISR, and (3) precision aerospace fires. Many nations are plagued with domestic financial problems while they still need to maintain a modern defense force to combat domestic, regional, and transnational threats. A multi-mission platform could be a cost-effective solution to expanding needed capabilities. Lt. Gen. Kisner stated in his Speech to XXI Seminario Internacional Cátedra Alfredo Kindelán, “a synchronized *Smart Defense* approach...is the key to success.”¹⁵¹ Recent U.S. Air Force (USAF) documents addressing pending

¹⁴⁸ Michael E. Haas, *Apollo's Warriors* (Maxwell AFB, AL: Air University Press, 2000), 2–9.

¹⁴⁹ NATO Special Operations Headquarters, *Special Air Warfare*, 5–6.

¹⁵⁰ U.S. Department of the Air Force, *AFDD 2–7*, 14.

¹⁵¹ Kisner, “Special Air Speech.”

force structure changes also call for an increased emphasis on multi-mission platforms as a cost saving tool. The document states, "...multi-role platforms provide more utility across the range of the potential missions for which we are directed, while we look to retire all aircraft of a specific type, allowing us to also divest the unique training and logistic support structure for that aircraft."¹⁵² Having such platforms would build a solid foundation for long term SOF effectiveness and future operational growth.

B. AIRCRAFT CANDIDATES

There are two families of medium-fixed-wing aircraft that warrant evaluation for SOF utility. The first is the Alenia Aeramacchi C-27 Spartan family. The C-27J and its no longer produced predecessors, the G-222 and C-27A, are "multi-functional, military aircraft designed and built for tactical transport and to support combat operations. [They can] operate autonomously in remote and austere environments and can take off and land from unprepared surfaces and airstrips."¹⁵³ The second family consists of the Airbus Military CASA/IPTN CN235 and the stretched fuselage version, the EADS CASA C295. Both aircraft are "highly versatile tactical airlifters ... capable of short take-off & landing (STOL) performance from unprepared short, soft and rough airstrips, as well as low level flight characteristics."¹⁵⁴

These two families of aircraft were chosen due to being combat proven, high usage among allies, relatively inexpensive acquisition costs, and capability to load cargo via a ramp door. Over 345 CN235s and C295s have been delivered to nations around the world and another 16 are on order.¹⁵⁵ In addition, approximately 50 C-27Js have been delivered and approximately 30 G-222 and

¹⁵² U.S. Department of the Air Force, "USAF Force Structure Changes," 3.

¹⁵³ Alenia Aeramacchi North America, "C-27J Spartan Tactical Transport Aircraft," 2010, <http://www.aleniana.com/c-27j-spartan-tactical-transport-aircraft>.

¹⁵⁴ Airbus Military, "C295 The Tactical Workhorse," <http://www.airbusmilitary.com/Aircraft/C295/C295About.aspx> and Airbus Military, "CN235 The Lower Cost Tactical Airlifter," <http://www.airbusmilitary.com/Aircraft/CN235/CN235About.aspx>.

¹⁵⁵ Airbus Military, "C295 Tactical Workhorse," and Airbus Military, "CN235 Lower Cost."

C-27As are still in service.¹⁵⁶ Table 15 demonstrates the large number of NATO allies already operating the G-222, C-27A, CN235, and C295.

| Aircraft | NATO Member Nations That Operate |
|-----------------|---|
| G-222 and C-27A | U.S., Italy (mostly retired) |
| C-27J | Bulgaria, U.S., Italy, Greece, Lithuania, |
| CN235 | France, U.S., Spain, Turkey |
| C295 | Czech Republic, Poland, Portugal, Spain |

Table 15. NATO Members Operating C-27A, C-27J, CN235, and C295 aircraft.¹⁵⁷

1. Alenia Aermacchi C-27¹⁵⁸

The C-27J Joint Cargo Aircraft (JCA) is designed to access a wide range of airfields, including short unprepared strips in hot and high altitude conditions, while transporting heavy loads. Development for the C-27J aircraft is complete and aircraft are in production. The C-27 airframe manufactured in Naples, Italy, by Alenia Aermacchi is modified by L-3 Communications of Waco, TX to become the C-27J. The C-27J is operated by the USAF Air National Guard. C-27J general characteristics include: a maximum takeoff weight of almost 70,000 pounds, an aircraft length of approximately 74 feet, and a wingspan of approximately 94 feet. The C-27J has the option of being equipped for probe/drogue refueling, and it has a maximum payload range in excess of 1,000

¹⁵⁶ Jane's All The World's Aircraft, "Alenia C-27J Spartan," February 15, 2012, [http://www4.janes.com.libproxy.nps.edu/subscribe/jawa/doc_view.jsp?K2DocKey=/content1/janes_data/yb/jawa/jawa0544.htm@current&Prod_Name=JAWA&QueryText=%3CAND%3E%28%3COCR%3E%28%28\[80\]c-27j+%3CIN%3E+body%29%2C+%28\[100\] +%28\[100\]c-27j+%3CIN%3E+title%29+%3CAND%3E+%28\[100\]c-27j+%3CIN%3E+body%29%29%29.](http://www4.janes.com.libproxy.nps.edu/subscribe/jawa/doc_view.jsp?K2DocKey=/content1/janes_data/yb/jawa/jawa0544.htm@current&Prod_Name=JAWA&QueryText=%3CAND%3E%28%3COCR%3E%28%28[80]c-27j+%3CIN%3E+body%29%2C+%28[100] +%28[100]c-27j+%3CIN%3E+title%29+%3CAND%3E+%28[100]c-27j+%3CIN%3E+body%29%29%29.)

¹⁵⁷ Walter Winter, "A Medium-Sized Airlift Analysis for NATO SOF," in *The NATO Special Operations Headquarters Air Warfare Center: A Smart Defense Approach*, ed. Arthur Davis and Keenan Yoho (Monterey, CA: Naval Postgraduate School, 2012).

¹⁵⁸ In evaluating the Alenia Aermacchi C-27 family of aircraft only the newer C-27J Spartan will be considered in this study. This is because while the United States and Italy still operate the G-222 and the C-27A, they are no longer produced and parts are becoming difficult and expensive to obtain.

miles.¹⁵⁹ The G-222/C-27A will not be considered as a viable platform for analysis since it is no longer manufactured and parts needs are no longer supported by the builder.



Figure 15. Photo of C-27J¹⁶⁰

2. CASA/IPTN CN235

The Airbus Military CASA/IPTN CN235 is a twin turbo-prop plane with STOL performance that is capable of operating from unpaved runways and has proven low level flying characteristics for tactical penetration. Development is complete and the current model, the CN235–300, has been in production since 1998. The U.S. Coast Guard (USCG) operates a maritime patrol variant of the CN235 as the HC-144 Ocean Sentry. With over 270 sold to over forty operators worldwide, the CN235 is one of the best-selling airlifters in the medium aircraft segment.¹⁶¹ CN235 general characteristics include: a maximum takeoff weight of

¹⁵⁹ U.S. Air Force Special Operations Command, AC-XX AoA, 22–23.

¹⁶⁰ C-27J Spartan, “Photo of C-27J,” <http://www.c27j.com/image-galleries/image-galleries/c-27j-spartan-flying>.

¹⁶¹ Airbus Military, “CN235 Lower Cost.”

almost 35,000 pounds, an aircraft length of approximately 70 feet, and a wingspan of approximately 84 feet. The CN235 has a maximum payload range of nearly 450 miles.¹⁶²



Figure 16. Photo of CN235¹⁶³

3. EADS CASA C295

The EADS/CASA C295 aircraft development is complete and aircraft are in production for primarily non-U.S. and commercial customers. The C295 is a further developed version of the CN235, but with a stretched fuselage, 50% greater payload capacity, and upgraded engines. The C295 can receive fuel in flight via optional probe and has a maximum payload range in excess of 700 miles. A modified variant of the C295 is sold as a maritime patrol and antisubmarine warfare platform. C295 general characteristics include: a

¹⁶² Jane's All The World's Aircraft, "Airtech CN-235," September 8, 2011, <https://janes.ihs.com.libproxy.nps.edu/CustomPages/Janes/DisplayPage.aspx?DocType=Reference&ItemId=+++1342564&Pubabbrev=JAWA>.

¹⁶³ Airbus Military, "Photo of CN235," <http://www.airbusmilitary.com/Aircraft/CN235/CN235About.aspx#content03>

maximum takeoff weight of approximately 51,100 pounds; an aircraft length of approximately 80 feet; and a wingspan of approximately 84 feet.¹⁶⁴



Figure 17. Photo of C295¹⁶⁵

C. MEASURES OF ANALYSIS

1. Cost

Two areas of consideration are analyzed when evaluating the candidate aircraft for cost. They are pure unit acquisition cost and the average cost per flying hour (CPFH).

a. *Acquisition Cost*

Aircraft acquired as excess defense articles or as used will have a greatly reduced acquisition costs. Costs of aircraft acquired in this manner will vary based on included purchases of support equipment, parts spares, etc. Table 16 displays estimated basic aircraft cost if nations were to contract for new C-27J, CN235, or C295 purchases. Although not evaluated in this study,

¹⁶⁴ U.S. Air Force Special Operations Command, AC-XX AoA, 24.

¹⁶⁵ Airbus Military, "Photo of C295," <http://www.airbusmilitary.com/Aircraft/C295/C295About.aspx#content01>

Table 16 includes recent USAF C-130J acquisition costs for comparison. Because a multitude of factors can influence an aircraft purchase price (e.g., number purchased, warranty contracts, nation purchasing), all dollar values are estimated ranges derived from previous U.S. government programs.

| Per Unit Acquisition Cost | | |
|---------------------------|----------|---|
| C-130J | \$66–70M | Estimates based on C-130J Department of Defense (DoD) 2012 USAF Budget Estimates ¹⁶⁶ |
| C-27J | \$32–37M | Estimate based on C-27J DoD 2012 USAF Budget Estimates ¹⁶⁷ |
| CN235 | \$20–25M | Based on U.S. Bureau of Land Management Smokejumper aircraft Screening and Evaluation Board (SASEB) CN235 data. ¹⁶⁸ FY2003 cost of \$17.085 inflated for 2012 using DoD Procurement inflation tables. ¹⁶⁹ |
| C295 | \$27–32M | Based on Air Force Special Operations Command (AFSOC) AC-XX AoA. BY2008 cost inflated using DoD Procurement inflation tables. ¹⁷⁰ |

Table 16. Medium-fixed-Wing Aircraft Per Unit Acquisition Cost Estimates.

b. Cost Per Flying Hour

Various U.S. agencies currently operating the platforms being analyzed—the USAF, USCG, and Department of State (DoS) calculate CPFH differently. Using open source data it is difficult to do an “apples-to-apples” comparison, so the costs presented are all rough estimates comprised from various sources.

¹⁶⁶ U.S. Department of the Air Force, *Department of Defense Fiscal Year (FY) 2013 President’s Budget Submission PDF*, (February 2012): 111. <http://www.saffm.hq.af.mil/shared/media/document/AFD-120210-115.pdf>.

¹⁶⁷ U.S. Department of the Air Force, *Department of Defense Fiscal Year (FY) 2012 Budget Estimates PDF*, (February 2011): 02–69. <http://www.saffm.hq.af.mil/shared/media/document/AFD-110211-038.pdf>.

¹⁶⁸ U.S. Bureau of Land Management, *EADS CASA CN-235 Preliminary Aircraft Evaluation for SASEB*, (2003): 56 <http://www.blm.gov/nifc/st/en/prog/fire/Aviation/Airops/aircraft.html>.

¹⁶⁹ U.S. Department of Defense, “Defense Cost and Resource Center,” http://dcarc.pae.osd.mil/reference/osd_ces_index.aspx.

¹⁷⁰ U.S. Air Force Special Operations Command, *AC-XX AoA*, 74.

C-27J: The CPFH for the C-27J is widely disputed in the defense industry media and DoD. Many articles assert that the C-27J CPFH is similar to that of the C-130J (\$9,100/hr).¹⁷¹ These reports attempt to include inaccurate manpower and other indirect costs. When calculating a CPFH composed of POL, unit operations costs, repair parts, and depot maintenance costs, the CPFH is reported to be about \$5,300 per hour.¹⁷²

CN235: The CN235 CPFH was derived from estimated USCG HC144 rates, and it is made up of similar expense categories to the C-27J CPFH. CPFH estimates for a CN235 are around \$3,000. Conklin & de Decker, an open source civilian aircraft cost estimator service, estimates the variable cost of the civilian variant of the CN235 to be \$1,784 per hours. This variable cost includes fuel, airframe maintenance, labor and parts, engine restoration and miscellaneous costs. This evaluation is focused on military utilization, so the \$3,000 CPFH will be used for comparison.¹⁷³

C295: No U.S. Government agencies currently operate the C295. In order to obtain a CPFH the theory that maintenance costs tend to be proportional to acquisition costs is used.¹⁷⁴ The C295 has an approximate 15% less acquisition cost when compared to the C-27J. Therefore, a 15% less CPFH would result in an approximate CPFH of \$4,500.

The above CPFH present a large disparity. By assuming 400 hours per year flight time per aircraft and the current CPFH increased for inflation, it is possible to calculate a 15 year cumulative operating cost. Over a 15 year timespan the CN235 and C295 have the lowest cumulative operating cost. Figure 18 illustrates that over this same period the C-27J would cost 15% more than the

¹⁷¹ Marcus Weisgerber, "USAF: We Didn't Inflate C-27J Cost," *Defense News*, March 19, 2012, <http://www.defensenews.com/article/20120319/DEFREG02/303190004/USAF-We-Didn-8217-t-Inflate-C-27J-Costs>

¹⁷² Brian Dougherty, SAF/AQQU, e-mail message to authors, March 24, 2012.

¹⁷³ U.S. Coast Guard HC-144 Platform Management Office, e-mail message to author, March 22, 2012 and Conklin & de Decker, "Aircraft Cost Summary"

¹⁷⁴ Tom Savage and Andrew Davies, "Delivering the Goods: The ADF's Future Battlefield Airlifter," *Australian Strategic Policy Institute*, March 2012, http://www.aspi.org.au/publications/publication_details.aspx?ContentID=333&pubtype=-1

C295 and 45% more than the CN235 to operate. All three candidate aircraft are significantly less expensive to operate than the C-130J.

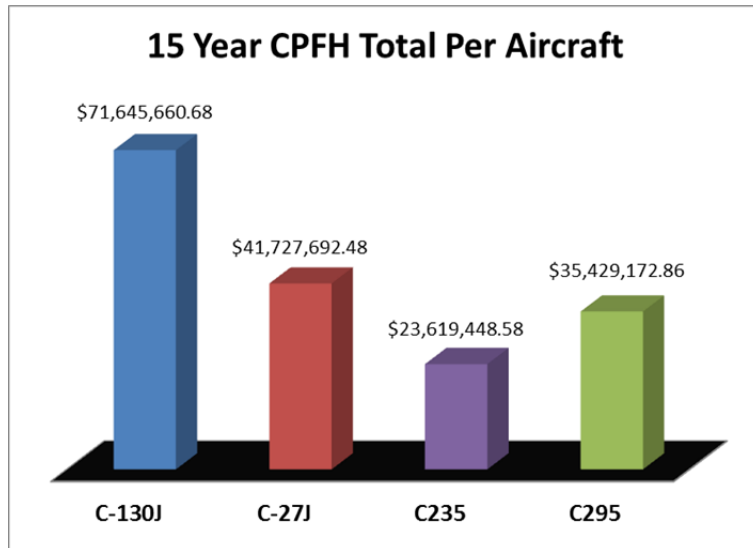


Figure 18. Cumulative 15-Year CPFH estimates per aircraft (based on 400 flight hours per year inflated at an average rate of 1.8% annually)

2. Mission Effectiveness

The second measure of analysis that is considered for this study is the mission effectiveness of each candidate aircraft. This effectiveness analysis will compare both aircraft performance specifications and capabilities. These specifications and capabilities are then evaluated against the hallmark qualities of SOF aviation, as listed in Chapter II.

a. Specifications

Table 17 shows that the C-27J surpasses both the CN235 and C295 in cargo capacity, range, and flight speed. Of note, the C-27J is able to transport over 5,000 pounds more cargo than the C295 at a 30% increased range. The CN235 is a smaller aircraft and as such has a smaller cargo capacity and reduced flight range when compared to the C-27J and C295. The CN235 does outperform both the C-27J and C295 in terms of STOL capabilities. While

the CN235 and C295 are able to transport more standard military pallets, both aircraft are over 2 feet shorter in cargo compartment height allowances than the C-27J. This reduced height allowance could prove problematic when transporting larger military cargo such as hard top High Mobility Multipurpose Wheeled Vehicles (HMMWVs) and small helicopters. Figure 19 shows a graphical depiction of the cargo height differences between the aircraft.

| Aircraft Specifications | | | | |
|--|---------------|---------------|---------------|--|
| Specification | C-27J | CN235 | C295 | Notes |
| Operating weight (empty) | 37,478 lbs | 20,850 lbs | 30,000 lbs | C-27J weight approximate |
| Max Takeoff weight | 67,241 lbs | 36,380 lbs | 51,000 lbs | C295 at overload |
| Max Fuel weight | 21,459 lbs | 9,150 lbs | 13,600 lbs | |
| Max Cargo weight | 25,353 lbs | 13,120 lbs | 20,400 lbs | |
| Range (Ferry) | 3,200 nm | 2,730 nm | 2,900 nm | |
| Range (Max poayload) | 1,000nm | 390 nm | 700 nm | C-27J at 22,046 lbs cargo |
| Range (13,200 lbs) | 2,300 nm | 390 nm | 2,000 nm | C-27J at 13,227 lbs cargo CN235 at 13,120 lbs cargo |
| Max Cruise Speed | 315 KTAS | 245 KTAS | 260 KTAS | |
| Max Altitude | 30,000 ft | 30,000 ft | 29,000 ft | |
| Takeoff field Length (Max GW, STD @SL) | 2,100 ft | 2,077 ft | 3,619 ft | |
| Landing field Length (at normal MTOW) | 2,264 ft | 2,025 ft | 2,392 ft | |
| External Length | 74 ft 7 in | 70.2 ft | 80 ft 2 in | |
| Length (Cargo) | 28 ft 1 in | 31 ft 8 in | 41 ft 8 in | |
| Height (Cargo) | 8 ft 4 in | 6 ft 3 in | 6 ft 3 in | |
| Pallet Positions (88x108) | 3 | 4 | 5 | |
| Troops | 68 | 51 | 71 | |
| Paratroops | 46 | 36 | 50 | |
| Medivac | 36 stretchers | 21 stretchers | 24 stretchers | |
| APU in flight operable | Yes | No | No | |

Table 17. Aircraft Specification Analysis¹⁷⁵

¹⁷⁵ Specifications data derived from C-27J Spartan, "C-27J Specs," <http://www.c27j.com/files/File/specs.pdf>, Jane's All the World's Aircraft, "Alenia C-27J.," Jane's All The World's Aircraft, "Airtech CN-235.," and Jane's All the World's Aircraft, "Airbus Military C-295.," February 8, 2012, <https://janes.ihs.com.libproxy.nps.edu/CustomPages/Janes/DisplayPage.aspx?DocType=Reference&ItemId=+++1343043&Pubabbrev=JAWA>

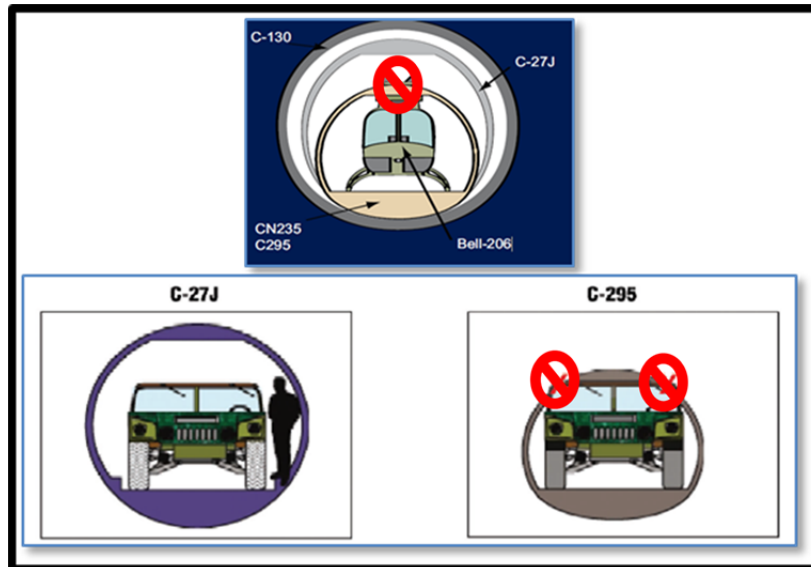


Figure 19. Images Comparing C-27, CN-235, C295 Cargo Compartment Size¹⁷⁶

b. Capabilities

Determining if an aircraft can support a mission set is of the utmost importance when selecting an aircraft. This portion of the study evaluates the medium-fixed-wing aircraft candidates and scores them against a set of “hallmark qualities” that SOF aircraft should have. The qualities were adopted from the 2008 study conducted by the NATO Special Operations Coordination Centre (NSCC), in which aircraft criteria for SOF aircraft performance capabilities were outlined. The exhaustive list stipulated by NSCC, found at Appendix A, was tailored to suit the purposes of this study—light (and medium) fixed wing SOF aircraft.¹⁷⁷ In Tables 18, 19, 20, 21 a “Yes” score implies that the aircraft manufacturer offers the capability. A “No” score implies that the capability is not a factory option for the aircraft. Given proper resources and time, in nearly all cases the aircraft examined can be modified to perform any of these hallmark qualities. Therefore, a binary scoring system was chosen in an effort to maintain

¹⁷⁶ C-27J Spartan, “C-27J Specs.”

¹⁷⁷ NATO Special Operations Coordination Centre, *Special Operations Forces Study*, Annex C.

maximum objectivity. By scoring aircraft in this manner, the study implies that no one quality is more valuable than another. When utilizing this study, organizations may determine that their interests value certain traits more than others, and should weight those traits accordingly.

As previously stated, *all* SOF aircraft must possess three qualities: be day/night/all-weather capable, possess enhanced navigation and communication equipment, and be threat survivable. Aircraft must be able to safely maneuver in instrument meteorological conditions in low illumination as well as daylight-visual meteorological conditions. In order to support SOF activities, adverse flight conditions must not degrade mission capability. Weather radar, de-icing equipment, and night vision goggle-compatible cockpits were among the considerations of this Hallmark Quality. As show in Table 18, all subject aircraft are available from the factory with suitable equipment.

Enhanced navigation and communications systems are also essential to SOF aircraft. Enhanced navigation systems include satellite-based navigation system, radar altimeters, redundant flight management systems, and traffic collision avoidance systems (TCAS). Enhanced communications systems include line-of-sight radios, beyond line-of-sight (e.g., satellite) radios, secure voice capability and data link capabilities. Again, all candidate aircraft satisfy this hallmark quality. However, the C-27J is slightly more capable—standard equipped with the AN/APN-241 high resolution ground mapping synthetic aperture radar and the Inmarsat SATCOM voice and data link radio.

The final hallmark qualities that *all* SOF aircraft must possess is to be threat environment survivable. Transiting hostile or denied areas requires the aircraft to have adequate aircraft survivability equipment (ASE). Example of ASE range from basic chaff/flare dispensers and missile warning systems, to advanced radar detection and directed infrared and laser countermeasures. Table 18 shows only the C-27J comes standard equipped with ASE systems. The C-27J incorporates a fully integrated defensive systems suite consisting of the AN/AAR-47A(V)2 (missile and laser warning system), AN/APR-39B(V)2

(radar warning receiver), and the AN/ALE-47(V) (chaff and flare dispenser).¹⁷⁸
 Such ASE is an optional modification on the CN235 and C295.¹⁷⁹

| Hallmark Qualities of ALL SOF Aircraft | | | |
|---|--------------|--------------|-------------|
| Quality | C-27J | CN235 | C295 |
| Day/Night/All Weather Capable | 1 | 1 | 1 |
| Enhanced Nav/Communication Capable | 1 | 1 | 1 |
| Threat Environment Survivable (Defensive Capabilities Dictated by Intended Utilization) | 1 | 0 | 0 |
| Score Total | 3 | 2 | 2 |

Table 18. Hallmark Qualities of ALL SOF Aircraft
 (Yes=1 point & No=0 points)¹⁸⁰

As stated in Chapter II, specialized air mobility may include infiltration, exfiltration, or resupply missions in diverse environments (e.g., hostile, denied, politically sensitive), and under varied circumstances (e.g., clandestine, low visibility, overt). Three hallmark qualities are essential to this mission set. The first hallmark quality that is important for specialized air mobility is the ability to operate into austere or semi-prepared airfields. All three candidate aircraft exhibit short landing field characteristics, possess tricycle type landing gear suitable for semi-prepared and grass runways, and possess differential disc brakes. As shown in Table 17, the C295 does require a longer landing and takeoff airfield length.

The second quality—the ability to operate at various flight altitudes (regimes)—is essential as diverse environments may dictate operations in low,

¹⁷⁸ U.S. Office of the Secretary of Defense, *Air Force Programs: C-27J*, <http://www.dote.osd.mil/pub/reports/FY2011/pdf/af/2011c27j.pdf>.

¹⁷⁹ Jane's All The World's Aircraft, "Airtech CN-235," and Jane's All the World's Aircraft, "Airbus Military C-295."

¹⁸⁰ A "Yes" score implies that the aircraft manufacturer offers the capability. A "No" score implies that the capability is not a factory option for the aircraft. Given proper resources and time, in nearly all cases an aircraft can be modified to perform any of these hallmark qualities. In addition, by scoring aircraft in this manner, the study is implying that no one quality is more valuable than another. In utilizing this study, organizations may determine that their interests value certain traits more than others, and should weight those traits accordingly.

medium, or high altitude. All three aircraft are able to operate in the region of 30,000 feet, and all three aircraft are able to pressurize for crew and passenger comfort. With their reinforced wing structures and low stall speeds, all three aircraft also perform exceptionally well in low altitude flight.

The final, and arguably most important, capability a SOF airlift aircraft must possess is the ability to airdrop. All three aircraft have similar capabilities and can perform paratroop and cargo airdrop operations out dual side doors and hydraulically operated cargo ramps. The major item differentiating the three aircraft is their size. The C-27J is rated to carry 46 fully equipped paratroops, can accommodate a max single run cargo airdrop of 13,228 pounds and is cleared for low altitude parachute extraction system (LAPES) and high altitude delivery (HAD) operations. Being slightly smaller, the CN235 can only accommodate 36 paratroops, but can still accomplish LAPES and HAD operations.¹⁸¹ The standout airdrop aircraft in the medium-fixed-wing field is the C295. The C295 can accommodate 50 fully equipped paratroopers, a 17,637 single run cargo airdrop, and can accomplish LAPES and HAD operations.¹⁸² Table 19 shows that the three candidate aircraft all scored similarly in the capability to perform specialized air mobility.

| Hallmark Qualities of Specialized Air Mobility | | | |
|---|--------------|--------------|-------------|
| Quality | C-27J | CN235 | C295 |
| Austere/Semi-prepared Field Capable | 1 | 1 | 1 |
| Ability to operate in various flight regimes (high, medium, and low altitude structure) | 1 | 1 | 1 |
| Airdrop Capable | 1 | 1 | 1 |
| Score Total | 3 | 3 | 3 |

Table 19. Hallmark Qualities of Spec. Air Mobility (Yes=1 point & No=0 points)

¹⁸¹ U.S. Bureau of Land Management, *EADS CASA CN-235*, 2.

¹⁸² Jane's All the World's Aircraft, "Airbus Military C-295."

Similar to light-fixed-wing aircraft, medium-fixed-wing aircraft have become popular platforms to utilize for ISR missions. In order to perform ISR operation in support of SOF, aircraft should have four hallmark qualities. The first—the ability to provide persistent coverage—is essential when performing ISR. For this study, persistent coverage is defined as endurance to remain on target for at least six hours unrefueled. Based on the aircrafts max cruise speed and ferry range, the C-27J has a flight duration of over 10 hours and both the CN235 and C295 exceed 11 hours max flight time. While these endurance times far exceed the six hour threshold, they will be reduced when mission equipment increases their operating weight and drag.

None of the candidate aircraft come standard-equipped to perform IMINT, SIGINT, ELINT, or COMINT gathering. While all aircraft can be modified to perform such ISR missions, modified versions of the CN235 and C295 are available from the factory. The CN235 and C295 are manufactured in maritime patrol and surveillance variants, and can be factory equipped with Airbus Military’s Fully Integrated Tactical System (FITS). The FITS system integrates a variety of mission sensors that can be used for various ISR mission tasks.¹⁸³ While not presently available, Alenia Aermacchi is developing a version of the C-27J that will also be factory ready to perform ISR with its enhanced electro-optical/infrared (EO/IR) targeting sensors.¹⁸⁴

In addition to performing stand-alone ISR, the ability to integrate fully into larger ISR networks has become crucial. Without the ability to transmit and receive real-time ISR data, mission updates, and retaskings, a platforms utility as an ISR asset is questionable. Of the three medium-fixed-wing aircraft, only the C-27J is factory ready to perform such tasks. The C-27J is equipped with Inmarsat compatible voice and data link satellite communications radios.

¹⁸³ Airbus Military, “Fully Integrated Tactical System,” <http://www.airbusmilitary.com/InnovationAndTechnology/FITS.aspx>

¹⁸⁴ Air Force-Technology.com, “Alenia Unveils New MC-27J at Farnborough 2012,” July 11, 2012, <http://www.airforce-technology.com/news/newsalenia-mc-27j-spartan>

Inmarsat systems allow for the dissemination and receipt of voice, data, and video feeds while in flight.¹⁸⁵ Again, the optional surveillance variants of the CN235 and C295 are better equipped to integrate into an ISR network.

As Table 20 shows, all three candidate aircraft come equipped to perform battlefield command and control (C2) and airspace deconfliction. All three aircraft have robust communications suites and cockpit displays sufficient to provide the needed situational awareness.¹⁸⁶

| Hallmark Qualities of Intelligence, Surveillance, and Reconnaissance | | | |
|---|--------------|--------------|-------------|
| Quality | C-27J | CN235 | C295 |
| Provide Persistent Coverage | 1 | 1 | 1 |
| Conduct any Combination of IMINT/SIGINT/ELINT/COMINT Gathering | 0 | 0 | 0 |
| Can be Integrated into Wider ISR Network (Inflight Dissemination and Receipt of ISR data) | 1 | 0 | 0 |
| Provide Battlefield C2 and Airspace Deconfliction | 1 | 1 | 1 |
| Score Total | 3 | 2 | 2 |

Table 20. Hallmark Qualities of ISR (Yes=1 point & No=0 points)

The final mission set that nations investing in SOF aviation should consider is precision aerospace fires. As Figure 7 explains, the key to precision aerospace fires is the ability to find, fix, track, target, engage, and assess targets by using some sort of weapon system. Typically, the ability to find, fix, track, target, and assess are accomplished by utilizing a variety of ISR equipment. Table 20 shows that none of the aircraft come standard equipped with such systems. In addition, none of the aircraft come munitions ready from the manufacturer. The C-27J, CN235, and C295 all have wing hardpoints that could be utilized for munitions carrying, but none are equipped with any sort of fire control management systems which is necessary for munitions employment.

¹⁸⁵ Jane's All the World's Aircraft, "Alenia C-27J."

¹⁸⁶ Jane's All the World's Aircraft, "Alenia C-27J.," Jane's All the World's Aircraft, "Airbus Military C-295." and Jane's All the World's Aircraft, "Airtech CN-235."

However, manufacturers for both the C-27J and the CN235 have mentioned interest in developing weaponized platform variants.¹⁸⁷

Similar to the ability to perform battle damage assessment (BDA), performing identification of friendly and enemy forces typically involves the utilization of multispectral imaging systems. Crewmembers on the candidate aircraft may be able to rudimentarily do this through visual identification out a window, but some sort of sensor suite would be required to perform this task with reliable accuracy. Table 21 shows that none of the candidate aircraft are capable of performing precision aerospace fires as equipped from the factory.

| Hallmark Qualities of Precision Aerospace Fires | | | |
|--|--------------|--------------|-------------|
| Quality | C-27J | CN235 | C295 |
| Precise Munitions Employment/BDA Capable | 0 | 0 | 0 |
| Positive ID of Friendly/Enemy Forces Capable | 0 | 0 | 0 |
| Score Total | 0 | 0 | 0 |

Table 21. Hallmark Qual. of Prec. Aerospace Fires (Yes=1 point, No=0 points)

D. AIRCRAFT AVAILABILITY

Another consideration for nations selecting a medium-sized fixed wing platform for SOF use is aircraft availability. Allies should consider both availability of aircraft as excess defense articles (EDA) for purchase through other nations and purchases and leases of new aircraft. Speed of acquiring newly manufactured or leased aircraft is not addressed in this study.

Options of C-27J availability exist in both EDA purchases and new purchase/lease. In early 2012, the USAF identified the fleet of 21 USAF C-27Js as being part of more than 280 aircraft identified for retirement as part of ongoing DoD budget cuts.¹⁸⁸ The future of these aircraft, which are still in production, is

¹⁸⁷ Air Force-Technology.com, "Alenia Unveils MC-27J." and Airbus Military, "Special Missions: Close Air Support/Gunships," <http://www.airbusmilitary.com/Missions/MissionsMilitary/Special.aspx>

¹⁸⁸ U.S. Air Force, "Air Force Priorities for a New Strategy with Constrained Budgets," February 2012, <http://www.af.mil/shared/media/document/AFD-120201-027.pdf>.

being analyzed by the USAF Air Staff and the Office of the Secretary of Defense (OSD). Although plans have not been finalized, the USAF is compiling lists of possible options as well as list of organizations and agency that may be interested in purchasing the C-27Js.¹⁸⁹ After hearing that the USAF would divest their fleet of C-27Js, Alenia announced their lack of support for the United States selling the 21 aircraft through Foreign Military Sales (FMS). In an interview, Alenia's CEO, Giuseppe Giordo, stated "If they want to sell additional airplanes as FMS, we will support them, but not those 21 airplanes." Giordo further stated, "In fact, we will do our best—not only us, but the Italian government—not to support those planes. In that case the U.S. government will be competing against our international campaigns in a market where 21 airplanes is a big deal."¹⁹⁰

A final, and more costly, option for C-27J procurement is to contract with Alenia for purchase of new aircraft. Estimated procurement costs were addressed in the previous section of this chapter.

Aircraft availability for the CN235 and C295 is a different story than the C-27J. Both aircraft are still in production and are heavily proliferated around the world. As there are no excess U.S. defense articles of these aircraft, the only option for allies to acquire them would be through a purchase from a third party/nation or a new lease or purchase. Both variants are heavily utilized in the civilian aviation market so viable lease and purchase options may exist, both from Airbus Military, as well as other third party vendors.

E. RECENT MEDIUM-FIXED-WING SUCCESSES

Many other military programs demonstrate how allies could succeed in modifying medium-fixed-wing aircraft to perform SOF mobility, SOF ISR, and SOF precision aerospace fires missions. Three examples of such programs are presented below.

¹⁸⁹ Vago Muradian, "Alenia Warns U.S. Over C-27J Sales," *Defense News*, February 27, 2012, <http://www.defensenews.com/article/20120227/DEFREG02/302270007/Alenia-Warns-U-S-Over-C-27J-Sales>.

¹⁹⁰ Muradian, "Alenia Warns U.S."

1. AC-130W Stinger II and KC-130J Harvest Hawk

In 2008, AFSOC began work on an acquisitions program, AC-XX, evaluating the utility of equipping medium-fixed-wing aircraft to perform a “mini-gunship” mission. Significant amounts of test data was acquired, including live fire testing and blast over pressure analysis for firing a modified ATK Bushmaster II 30mm gun out the side of a C-27.¹⁹¹ Following the Congressionally directed cancellation of the AC-XX program, efforts were redirected to modifying AFSOC’s fleet of AC-130W (dubbed Dragon Spear) aircraft. At the same time, the U.S. Marines began a similar program, piggybacking on AFSOC’s successes, to modify their KC-130J (dubbed Harvest Hawk) aircraft. Both aircraft were modified to perform battlefield overwatch and are equipped with a precision strike package—consisting of a 30mm gun, stand-off precision guided munitions, small diameter bombs, and a suite of visual and EO/IR sensors. Both programs used proven rapid acquisition principles and combat proven technology to modify and deploy the aircraft to combat in less than 18 months.¹⁹² Estimated costs of modifying the AC-130W aircraft with the precision strike package is \$39 million apiece.¹⁹³

¹⁹¹ Charles McClenahan, e-mail message to authors, March 14, 2012 and U.S. Air Force Special Operations Command, *AC-XX AoA*.

¹⁹² U.S. Air Force, “AC-130W Stinger II Fact Sheet,” September 24, 2012, <http://www.af.mil/information/factsheets/factsheet.asp?fsID=4887> and United States Marine Corp, *Harvest Hawk ISR/Weapons Mission Kit Brief*, (Washington, DC: HQ, U.S. Marine Corp, 2010).

¹⁹³ U.S. Air Force, “AC-130W Fact Sheet.”

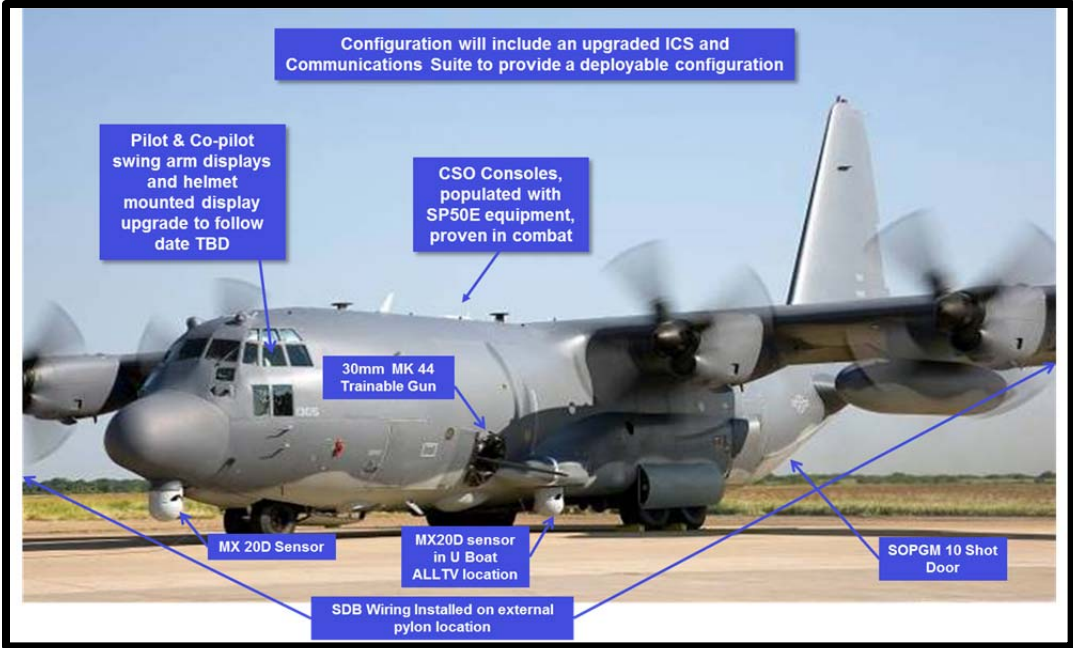


Figure 20. Picture outlining initial Dragon Spear Configuration.¹⁹⁴

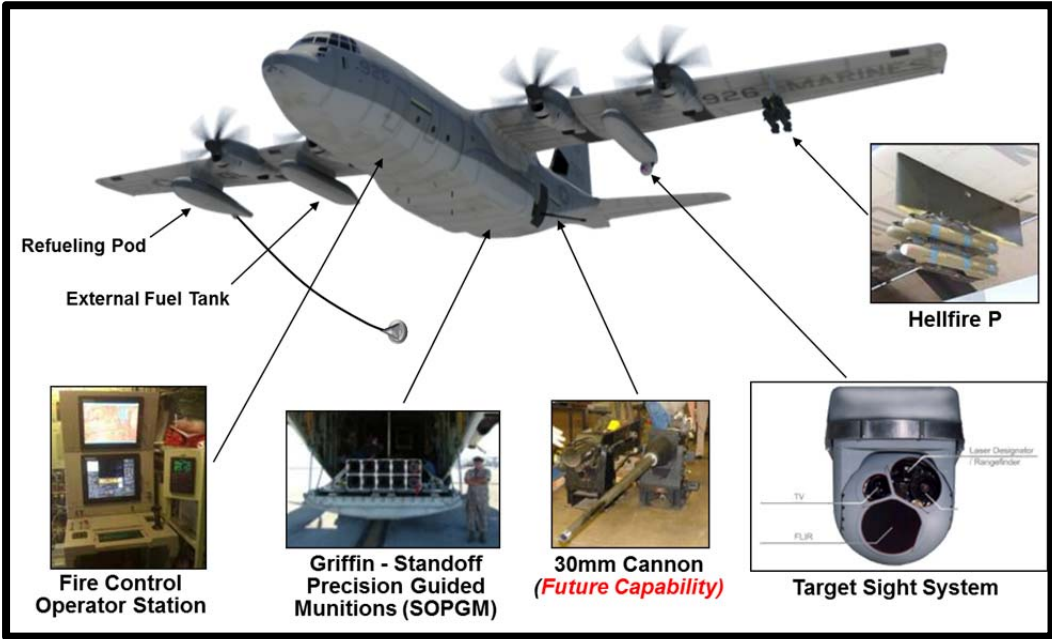


Figure 21. Dipiction of U.S. Marine Corps Harvest Hawk Platform.¹⁹⁵

¹⁹⁴ U.S. Air Force Special Operations Command, *Dragon Spear CR-3 Configuration Brief*, March 15, 2011.

2. Gunship in a Box

Another medium-fixed-wing modification example is the Air Force Research Labs (AFRL) and U.S. SOUTHCOM “Gunship in a Box” program. The program is a cooperative research and development agreement with Alliant Techsystems Inc. (ATK) to develop a lightweight/low-cost gunship module. This effort will provide a true roll-on/roll-off—install in 4 hours/uninstall in 3 hours—side firing weapons capability that can be used on any number of existing cargo aircraft (including C-27J, CN235, and C295). The system, which includes an AFRL modified ATK stretched 30mm gun and 500 rounds of ammunition at a weight of less than 3000 pounds, will require no modifications to the host aircraft and should cost less than \$675,000 per unit.¹⁹⁶ A more integrated variation that would include a sensor ball coupled to the fire control system is projected to cost roughly \$1.9 million.¹⁹⁷



Figure 22. Picture of the Gunship in a Box roll-on/roll-off 30mm gun pointing out rear troop compartment door.

¹⁹⁵ U.S. Marine Corps, *Harvest Hawk ISR/Weapons Mission Kit Brief*.

¹⁹⁶ Charles McClenahan, e-mail message to authors, March 14, 2012.

¹⁹⁷ Charles McClenahan, e-mail message to authors, September 21, 2012.

3. Jordanian Gunship

In early 2011 Jordan's King Abdullah II Design and Development Bureau awarded a contract to ATK to modify two CN235 military transport aircraft with ATK's new Light Gunship Special Mission Aircraft Capabilities package. These aircraft—which are scheduled to be delivered in early 2013—will provide an enhanced capability to conduct responsive defense, counterinsurgency, and border surveillance and security missions.¹⁹⁸ ATK's package will integrate day and night electro-optical ISR sensors, integrate targeting fire control equipment, a laser target designator, aircraft self-protection equipment, and an armament package which includes Hellfire missiles, 2.75-inch rockets, and a M230 link-fed 30mm gun system.¹⁹⁹ While exact cost figures have not been released, the ATK-modified Jordanian gunship is touted as a “highly-capable and cost-effective special mission aircraft” that will not have the steep price tag of the \$190M apiece like the U.S. AC-130U Spooky gunships.²⁰⁰

¹⁹⁸ Frank Grealish, “ATK to Modify Two Jordanian CASA CN-235's Into Gunships,” *Air Forces Review*, February 21, 2011, <http://airforcesreview.com/news-article/2011/02/21/117/ATK-to-Modify-Two-Jordanian-CASA-CN-235s-into-Gunships.html>.

¹⁹⁹ Mohanad Altamimi, “Jordan Orders CASA C-235 Gunship Conversion,” *Air Aviation News*, March 5, 2011, <http://www.airaviationnews.com/war/an/jordan-orders-casa-c-235-gunship-conversion>.

²⁰⁰ Frank Grealish, “ATK to Modify.” and Global Security, “Ac-130 Project Gunship II,” <http://www.globalsecurity.org/military/systems/aircraft/ac-130-specs.htm>.



Figure 23. Picture of proposed Jordanian ATK modified CN235 Gunship.²⁰¹

F. CONCLUSION

This portion of the study was intended to explore procurement, associated costs, and capabilities of candidate medium-fixed-wing aircraft. When properly employed, it is undeniable that having such a platform provides a solid foundation for long-term SOF aviation success. While all three candidate platforms possess some of the hallmark qualities, none possess everything needed to be a master at all SOF aviation mission sets. Nations interested in such platforms for SOF aviation will need to carefully prioritize which qualities and capabilities they most value prior making acquisition decisions.

²⁰¹ ATK, "Light Gunship," <http://www.atk.com/Products/documents4-1/DES%20-%20Light%20Gunship.pdf>.

V. ANALYSIS AND RECOMMENDATIONS

A. INTRODUCTION

As nations face increased irregular and unconventional threats, special operations aircraft continue to emerge as the preferred provider of support to special operations ground forces. If properly selected—suitable to help meet an individual nation’s strategic priorities—low cost light- and medium-fixed-wing aircraft can prove to be treasured assets in support of a nation’s internal and external defense. Furthermore, special operations aircraft provide a versatile mechanism that is ideally suited to combat ambiguous and dynamic irregular threats, while being more agile, flexible, and capable than their conventional counterparts.

A key component of effective special operations aviation is the proper selection of aircraft to perform the mission. While highly specialized niche aircraft have proven to be vital to the United States’ special operations forces (SOF) aviation capability, it is unrealistic to assume that all U.S. allies can secure the same aircraft for their use. Most nations lack the resources to procure, maintain, and employ these assets with proficiency for the long term. Given the above, this study performed an analysis of light- and medium-fixed-wing aircraft to determine the relative utility of commercially available off-the-shelf candidate platforms. After evaluating candidate aircraft based on measures of cost and effectiveness, the study was able to identify a standout aircraft in both the light- and medium-fixed categories.

B. RECOMMENDATIONS

1. Light-Fixed-Wing

Evaluation of the four light-fixed-wing aircraft on acquisition cost, cost per flying hour (CPFH), aircraft specifications, and scoring against the hallmark qualities of SOF aviation revealed that any of these candidate aircraft could effectively support SOF missions. As a summary of the cost data presented in

Chapter III, Table 22 shows that the Pilatus PC-6 Porter carries the lowest acquisition cost and most economical CPFH. Thus, the “true cost to operate” the Porter is the lowest of all four candidate aircraft. At the other end of the spectrum, the Viking Air DHC-6 Twin Otter is the most expensive candidate to procure, and also costs the most to operate, nearly doubling the Lifespan Cost of the Porter. It should be noted that these aircraft, while within the parameters set forth to qualify as “light-fixed-wing” aircraft, possess substantially different characteristics (e.g., specifications and performance).²⁰²

| Light-Fixed-Wing Aircraft Cost Data Summary | | | | |
|--|---------------|---------------|---------------|----------------|
| Cost | C-208 | BN2T | PC-6 | DHC-6 |
| Acquisition Cost | \$2.3M | \$2.1M | \$2.0M | \$3.6M |
| 15-year CPFH | \$4.8M | \$6.3M | \$4.4M | \$9.1M |
| Lifespan Cost | \$7.1M | \$8.4M | \$6.4M | \$12.7M |

Table 22. Light-Fixed-Wing Aircraft Cost Data Summary

The scoring of hallmark qualities of SOF Aviation produced interesting results. As shown in Table 23, the Britten-Norman BN2T-4S Defender had the highest aggregate total, scoring well in each category. The category that put the Defender out front was its increased capacity to perform the intelligence, surveillance, and reconnaissance (ISR) mission. In the category of specialized air mobility, all four candidate aircraft excelled, as each platform was initially designed to haul passengers and freight. Interesting to note is that none of the four light-fixed-wing aircraft candidates scored well in the precision aerospace fires category. This can be attributed to the fact that none of the aircraft manufacturers examined offer weaponized versions of their product.

²⁰² For specifics of aircraft specifications and performance data, see Tables 8 and 9 in Chapter III.

| Light-Fixed-Wing Aggregate Scoring of Hallmark Qualities | | | | |
|---|--------------|-------------|-------------|--------------|
| Category | C-208 | BN2T | PC-6 | DHC-6 |
| ALL SOF Aviation | 1 | 2 | 2 | 2 |
| Specialized Air Mobility | 3 | 2 | 3 | 3 |
| Intelligence, Surveillance, and Reconnaissance | 1 | 4 | 2 | 2 |
| Precision Aerospace Fires | 0 | 1 | 1 | 1 |
| Aggregate Total | 5 | 9 | 8 | 8 |

Table 23. Light-Fixed-Wing Aggregate Scoring of Hallmark Qualities

2. Medium-Fixed-Wing

Evaluation of the three medium-fixed-wing aircraft for acquisition cost, CPFH, aircraft specifications, and against the hallmark qualities of SOF aviation—derived in Chapter II—showed that any of the three candidate aircraft could perform sufficiently as a SOF platform. The C-27J however, clearly represents the best off the shelf medium aircraft for SOF use. Based on aircraft acquisition cost and CPFH, Table 24 shows that the CN235 appears to be the best option. The CN235 is 33% less in acquisition cost and more than 40% less in CPFH than the C-27J.

| Medium-Fixed-Wing Aircraft Cost Data Summary | | | |
|---|----------------|----------------|----------------|
| Category | C-27J | CN235 | C295 |
| Acquisition Cost | \$37M | \$25M | \$32M |
| 15-year CPFH | \$41.7M | \$23.6M | \$35.4M |
| Lifespan Cost | \$78.7M | \$48.6M | \$67.4M |

Table 24. Medium-Fixed-Wing Aircraft Cost Data Summary

However, the CN235 is lacking in certain capabilities. Based on pure aircraft specifications (presented in Chapter IV, Table 17), the C-27J is the clear achiever. The C-27J can go faster, farther, and carry a heavier load. It is worth noting that the C295 can carry more pallets and troops, but the C-27J's cargo compartment is better sized for large military equipment. Also, the CN235 is

smaller and therefore slightly more versatile as far as small airfield operations and STOL performance. Nations that value a smaller and less expensive aircraft should certainly consider the CN235.

When considering the medium aircraft's satisfaction of the hallmark qualities of SOF aviation, it is clear that all three are factory equipped to perform the SOF airlift mission. Table 25 denotes each medium aircraft's aggregate score for the hallmark qualities of SOF aircraft. The C-27J is however more suited to operate in a threat environment—an important delineation for a SOF aircraft. When considering the aircraft based on the hallmark qualities of SOF ISR, the C-27J is only slightly better equipped. All three aircraft lack any sort of equipment to conduct IMINT/SIGINT/ELINT/COMINT gathering. However, the C-27J is supplied with Inmarsat compatible voice and data link satellite communications radios that allow it, *without* modification, to integrate into a larger ISR network. Finally, based on the hallmark qualities of precision aerospace fires aircraft, all three candidates are ill equipped. In order to perform the strike mission set at even a rudimentary level, all candidate aircraft would require significant modifications. Given proper amounts of time and money, any of these aircraft could be made to better support precision aerospace fires and ISR missions.

| Medium-Fixed-Wing Aggregate Scoring of Hallmark Qualities | | | |
|--|--------------|--------------|-------------|
| Cost | C-27J | CN235 | C295 |
| ALL SOF Aviation | 3 | 2 | 2 |
| Specialized Air Mobility | 3 | 3 | 3 |
| Intelligence, Surveillance, and Reconnaissance | 3 | 2 | 2 |
| Precision Aerospace Fires | 0 | 0 | 0 |
| Total | 9 | 7 | 7 |

Table 25. Medium-Fixed-Wing Aggregate Scoring of Hallmark Qualities

When considering the aircraft based on availability, all three again represent good options. All three aircraft are in production, so replacement parts should be readily available. The only area of difference is that the CN235 and

C295 are more widely proliferated in the civilian and military sectors. This could afford a nation the ability to acquire aircraft in the used market.

C. CONCLUSION

This study sought to analyze select light- and medium-fixed-wing aircraft for their utility in support of SOF. In an industry that thrives on commercially-available off-the-shelf (COTS) modifications and carry-on/carry-off (COCO) equipment, it is difficult to determine the “best” platform. To help level the playing field, this study eliminated COTS and COCO variations and limited platform characteristics to simply what the manufacturers offer as “stock” aircraft. This is a very important aspect for prospective SOF aircraft-capable organizations to consider. With the appropriate COTS and COCO modifications, any of the seven platforms examined have the potential to excel in any one or all of the categories deemed essential for SOF aviation. Furthermore, a clear delineation must be made as to what the organization deems a priority. A SOF outfit that requires airlift but no ISR capability, for example, should disregard prospective platforms’ scores in the ISR category. This methodology provides a would-be SOF aircraft-capable organization a modular approach to which it can add or eliminate specific preferences based on individual priorities. Lastly, the model can be amended to incorporate a weighted scale to account for the organization’s specific priorities.

As stated above, any of the light-fixed-wing aircraft examined would serve as a fine platform to support an organization’s SOF activities. This study’s scoring shows that the Britten-Norman BN2T-4S Defender is the most capable aircraft upon leaving the manufacturer’s assembly line. The Defender scored well in all of the hallmark qualities, but it was a standout performer in ISR missions. That said, for an organization that does not place a high emphasis on ISR for its acquisition, another candidate platform might be more desirable. If cost savings is the overarching priority, this study would recommend the Pilatus PC-6 Porter. The Porter carries the lowest price tag as well as the lowest lifespan cost of the four light-fixed-wing aircraft examined. While the upfront cost is only \$100,000

less than the Defender, over an expected lifespan of 15 years, employing the Porter would cost \$2 million less than the “most capable” platform observed – per aircraft. Depending on the size of a nation’s aircraft fleet, this cost variance would have a compounding effect.

Given off-the-shelf capabilities, it is clear that the C-27J represents the best aircraft available for medium-fixed-wing SOF utility. The C-27J possesses better specifications and capabilities—a fact that may prove more important than cost in the long run. If cost savings is the overall priority, the CN235 would still be a suitable aircraft for basic SOF aviation use. Over a 15-year life span, the CN235 could save a nation \$30 Million in costs to acquire and operate. Acquiring a medium-fixed-wing aircraft that can flawlessly support all SOF mission sets without any modification will prove difficult to any nation. Options for modifications do exist—both pre-acquisition from the manufacturer and post-acquisition aftermarket—to transform any aircraft. Consideration should however be given to something that the United States has shown repeatedly—substantial or extensive modifications to baseline aircraft can prove costly and complicated. Regardless of shortfalls and limitations, any aircraft a nation decides to procure, equip, and utilize for SOF support will be a versatile force multiplier in the fighting of irregular threats and achieving national objectives.

APPENDIX: NATO SOF AVIATION MINIMUM AND DESIRED REQUIREMENTS

A. TAB 1. NATO AIRCRAFT CAPABILITIES REQUIREMENTS

Tables 1, 2, and 3 present the SOF aircraft criteria established by the NATO Special Operations Coordination Center in their 2008 *NATO Special Operations Forces Study*. The list of aircraft performance capabilities delineates the minimum and desired capabilities that NATO SOF mobility, strike, and ISR aircraft should possess.²⁰³

Table 1. List of NATO Air Mobility Platform Minimum and Desired Capabilities

| SOF Mobility Minimum Requirements |
|--|
| Low light operations |
| NVG operations (compatible lighting) |
| Visual low alt navigation/terrain avoidance |
| Precise navigation (<75 meters <2 minutes time accuracy) redundant navigation system (i.e., dual INS, INS/GPS) |
| Secure communications |
| IR countermeasures and electronic countermeasures. IR missile warning system |
| Operate in austere locations |
| FARP capable (receiver or tanker) |
| Helicopter air-air refueling |
| Reduced visibility landings |
| Conduct IR marked landings/drop zone operations |
| Conduct unprepared landing surface operations |
| Static line, free-fall airdrop |
| Auto response to external interrogation by mil/civ ground/air interrogators |
| Operate in CBRN environment |
| SOF Mobility Desired Requirements |
| All environment flight operations |
| IFR low altitude/terrain avoidance |
| Conduct precision airdrop (<95 meter accuracy) |
| Autonomous ID of landing and drop zones |
| Conduct automatic computed air release point systems (ACARPS) operations |
| Operations into unmarked landing/drop zones |
| Discreet or covert operations |
| Multi-ship formations with dissimilar aircraft |
| Improved situational awareness suite (IR sensor, enhanced radar, etc.) |
| Enhanced mission management system with precision timing +/- 30 seconds |
| Automated self-contained approach capes |
| Extended range (auxiliary tanks or in-flight refueling) |
| Beyond Line of sight communications |
| Data Link communications |
| Directed IR countermeasures |
| Ballistic armor |
| Automated IRCM/ECM suite |
| Reduced aircraft signature |

²⁰³ NATO Special Operations Coordination Centre, *Special Operations Forces Study*, C13-C18.

Table 2. List of NATO Air Strike Platform Minimum and Desired Capabilities

| SOF Air Strike Minimum Requirements |
|---|
| Conduct positive control of air strike |
| Conduct precision munitions employment against static and moving targets |
| Conduct ID of friendly forces |
| Provide BDA recorder |
| Auto response to external interrogation by military/civilian ground/air interrogators |
| Precise ordnance delivery in extremely close proximity to friendly forces (inside danger close) |
| SOF Air Strike Desired Requirements |
| Fire control computer |
| Low light level television |
| Infrared detection set |
| Strike radar (all weather precision engagement) |

Table 3. List of NATO ISR Platform Minimum and Desired Capabilities

| SOF Air ISR Minimum Requirements |
|--|
| Conduct visual/photo collection and thermal imaging |
| Conduct wide area sensor surveillance for the detection and tracking of slow moving ground targets and of distinguishing between tracked and wheeled vehicles by day or night, clear or adverse weather |
| Conduct preplanned imagery collection with in-flight mission update/retasking capability |
| Record mission history and electronic support data for post-mission analysis |
| Provide in-flight dissemination of reconnaissance imagery and data to appropriate receiving stations, in near real time when required |
| Provide very high quality imagery at ranges up to 100km |
| Provide very high quality optical and IR imagery - clear conditions, day/night |
| Provide very high quality optical and IR imagery (IR NIIRS>6) from low to medium altitude (10,000–45,000 ft) |
| Provide very high quality optical and IR imagery (multi-spectral NIIRS>6) from low to medium altitude (10,000–45,000 ft) |
| Provide very high quality optical and IR imagery (optical NIIRS>7) from low to medium altitude (10,000–45,000 ft) |
| Provide very high quality optical and IR imagery (still frame, video) |
| Conduct signal intelligence (SIGINT) |
| Transmit collected signals data to appropriate receiving stations, near real time when required |
| Conduct unmanned SIGINT missions in operational situations when aircrew should not be risked |
| Conduct electronic signals intelligence (ELINT) & communications intelligence (COMINT) |
| Conduct wide area sensor surveillance for collecting, direction finding and locating the source of all militarily significant radio frequency communications and non-communications signals. Quality of collection should be of sufficient quality for emitter recognition |
| Operate by day and night in all weathers |
| Provide secure, robust, reliable line of sight (LoS) and beyond line of sight (BLoS) communications |
| Provide auto response to electronic interrogation by military/civil ground & airborne interrogators |
| Provide in-flight review of reconnaissance data |
| Integrate into the wider joint intelligence, surveillance and reconnaissance (JISR) network |
| Provide persistent coverage of an area of interest or broad area coverage of several areas of interest |
| Conduct operations at medium altitude (10,000–45,000') with long endurance (greater than 8 hours) |
| Penetrate denied airspace |
| SOF Air ISR Desired Requirements |
| Attack surface targets by day and night |
| Attack surface targets in all weather conditions |
| Attack surface targets in all terrain conditions |
| Attack fixed hard and soft targets |
| Attack mobile targets, including armored vehicles attempting concealment to avoid detection |
| Attack ground targets at medium range from the forward line of troops (FLOT) |

LIST OF REFERENCES

- Acquisitions Central. "Definitions."
https://www.acquisition.gov/far/html/Subpart%202_1.html#wp1145508.
- Airbus Military. "C295 The Tactical Workhorse."
<http://www.airbusmilitary.com/Aircraft/C295/C295About.aspx>.
- . "CN235 The Lower Cost Tactical Airlifter."
<http://www.airbusmilitary.com/Aircraft/CN235/CN235About.aspx>.
- . "Fully Integrated Tactical System."
<http://www.airbusmilitary.com/InnovationAndTechnology/FITS.aspx>.
- . "Special Missions: Close Air Support/Gunships."
<http://www.airbusmilitary.com/Missions/MissionsMilitary/Special.aspx>.
- Air Force-Technology.com. "Alenia Unveils New MC-27J at Farnborough 2012."
July 11, 2012. <http://www.airforce-technology.com/news/newsalenia-mc-27j-spartan>.
- Alenia Aermacchi North America. "C-27J Spartan Tactical Transport Aircraft."
2010. <http://www.aleniana.com/c-27j-spartan-tactical-transport-aircraft>.
- Altamim, Mohanad. "Jordan Orders CASA C-235 Gunship Conversion." *Air Aviation News*. March 5, 2011.
<http://www.airaviationnews.com/war/an/jordan-orders-casa-c-235-gunship-conversion>.
- Army Technology. "Britten-Norman BN-2T-4S Defender 4000 Surveillance Aircraft, United Kingdom." <http://www.army-technology.com/projects/defender-4000/>.
- Assistant Secretary of the Air Force for Acquisition and Deputy Undersecretary of the Air Force for International Affairs. *Afghanistan Light Air Support & Basic Trainer/Light Lift Status Update, Version 2*. Washington, DC: HQ USAF, Pentagon. September 2010.
- . *Afghanistan Light Air*. Washington, DC: HQ USAF, Pentagon. 2010.
- ATK. "Light Gunship." <http://www.atk.com/Products/documents4-1/DES%20-%20Light%20Gunship.pdf>.
- Australian Strategic Policy Institute. "The Cost of Defence: Defence Budget Brief 2011–2012." http://www.aspi.org.au/publications/publication_details.aspx?ContentID=294.

BAE Systems. "BAE Systems delivers Swing Role Radar capability to Eurofighter Typhoon." http://www.baesystems.com/Newsroom/NewsReleases/2001/press_190620012.html.

Britten-Norman Aircraft Limited. *Defender: More Than Meets the Eye*. <http://www.britten-norman.com/brochures/defender.pdf>.

———. "Defender General Information." <http://www.britten-norman.com/defender/>.

Cessna Aircraft Company. "Cessna 208 Caravan (with optional cargo pod) Performance Section." *Pilot Information Manual*. http://textron.vo.llnwd.net/o25/CES/cessna_aircraft_docs/caravan/grandcaravan/grandcaravan_pim.pdf.

———. "Endurance Profile with Cargo Pod Installed." *C-208B Pilot Information Manual*. http://textron.vo.llnwd.net/o25/CES/cessna_aircraft_docs/caravan/grandcaravan/grandcaravan_pim.pdf.

———. *Grand Caravan Optional Equipment Guide—Effective for Aircraft to be Delivered in 2012*. http://textron.vo.llnwd.net/o25/CES/cessna_aircraft_docs/caravan/grandcaravan/grandcaravan_oeg.pdf.

Collins, John M. *Green Berets, SEALs & Spetsnaz: U.S. and Soviet Special Military Operations*. Washington, DC: Pergamon Bassey's, 1987

Conklin and de Decker. "Aircraft Cost Summary." <http://www.conklindd.com/CDA/Library/ACCostSummary.aspx>.

Dorr, Robert F. "AT-6 Demonstration a Good Deal." *Air Force Times*. April 30, 2010.

———. "AT-6 Texan II Armed Aircraft Showing Progress on Several Fronts." *Defense Media Network*. March 15, 2011.

EuroControl. "Revising wake turbulence categories to gain capacity." http://www.eurocontrol.int/eec/public/standard_page/EEC_News_2008_3_RECAT.html.

Flatley, James H. "Meeting the Needs of the Warfighter from the Air." *The Hill's Congress Blog*. May 4, 2011.

Global Security. "Past Military Cargo Aircraft." <http://www.globalsecurity.org/military/systems/aircraft/u-27.htm>.

———. "Ac-130 Project Gunship II." <http://www.globalsecurity.org/military/systems/aircraft/ac-130-specs.htm>.

- Gorka, Sebastian L.V. "The Age of Irregular Warfare: So What." *Joint Forces Quarterly* 58, 3rd quarter (2010): 32–38.
- Grant, Greg. "Schwartz Shoots Down COIN Plane." *DoD Buzz*.
<http://www.dodbuzz.com/2010/05/06/schwartz-shoots-down-light-fighter/>.
- Grealish, Frank. "ATK to Modify Two Jordanian CASA CN-235's Into Gunships." *Air Forces Review*. February 21, 2011. <http://airforcesreview.com/news-article/2011/02/21/117/ATK-to-Modify-Two-Jordanian-CASA-CN-235s-into-Gunships.html>.
- Haas, Michael E. *Apollo's Warriors*. Maxwell AFB, AL: Air University Press, 2000.
- Headquarters, United States Air Force. "Posturing the Air Force for the Long War: A Strategic Perspective." pre-decisional briefing, Air Staff, Pentagon, September 13, 2006.
- Headquarters, U.S. Air Force Special Operations Command. "Background Paper on U-28 Upgrade Cycle." Hurlburt Field, Florida, March 13, 2012.
- Hoyle, Craig. "France's Rafale Fighter Proves its 'Omni-Role' Skills." *Flightglobal International*. June 14, 2011. <http://www.flightglobal.com/news/articles/frances-rafale-fighter-proves-its-omnirole-skills-357687/>.
- Jane's All The World's Aircraft. "Alenia C-27J Spartan." February 15, 2012.
- . "Airtech CN-235." September 8, 2011.
<https://janes.ihs.com.libproxy.nps.edu/CustomPages/Janes/DisplayPage.aspx?DocType=Reference&ItemId=+++1342564&Pubabbrev=JAWA>.
- Jet Exchange. "Turboprop General Comparison." www.jetexchange.com/Files/XL/TurbopropGeneralComparison.xls.
- Keating, Edward G. and Frank Camm. "How Should The U.S. Air Force Depot Maintenance Activity Group be Funded: Insights from Expenditure and Flying Hour Data." *The RAND Corporation*. 2002. <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA408964>.
- Kisner, Frank. "Special Air Warfare and a Coherent Framework for NATO SOF Aviation." Speech to XXI Seminario Internacional Cátedra Alfredo Kindelán, Madrid, Spain, November 14, 2011.
- The Military Dictionary. "multi-role." <http://www.military-dictionary.org/DoD-Military-Terms/A/6/multi-role>.
- . "swing-role." <http://www.military-dictionary.org/DoD-Military-Terms/A/6/swing-role>.

- Military Factory. "Military Multirole Aircraft."
<http://www.militaryfactory.com/aircraft/military-multirole-aircraft.asp>.
- Morrisson, Scott. "Closing the Gap." *CPM Forum: NATO Special Operations Forces*, 2nd edition (2011): 6–7.
- Muradian, Vago. "Alenia Warns U.S. Over C-27J Sales." *Defense News*, February 27, 2012. <http://www.defensenews.com/article/20120227/DEFREG02/302270007/Alenia-Warns-U-S-Over-C-27J-Sales>.
- Newton, Richard D. *JSOU Report 06–8: Special Operations Aviation in NATO*. Hurlburt Field, FL: The JSOU Press, 2006. http://usacac.army.mil/cac2/cgsc/carl/docrepository/JSOU_Report_06_8.pdf.
- North Atlantic Treaty Organization. "Active Engagement, Modern Defence." November 19, 2010. http://www.nato.int/cps/en/natolive/official_texts_68580.htm.
- . *AJP-3.5: Allied Joint Doctrine for Special Operations*. January 2009.
- . *Special Air Warfare Manual Version 1.0*. Shape, Belgium, 2010.
- North Atlantic Treaty Organization Special Operations Coordination Centre. *The North Atlantic Treaty Organization Special Operations Forces Study*. December 4, 2008.
- North Atlantic Treaty Organization Special Operations Headquarters. *Special Air Warfare Manual*. March 2010.
- North Atlantic Treaty Organization Special Operations Headquarters. *Special Operations Air Group: Concept for Development and Organization*. April 22, 2010.
- Pietrucha, Michael W., Mike Saridakis, and David Torres-Laboy. *OA-X Enabling Concept*. Langley AFB, VA: Air Combat Command, 2008.
- Pilatus Aircraft Limited. *PC-6 Turbo Porter: Anywhere, Anytime, in Any Environment*. <http://www.pc-6.com/vPilatus-ProductBrochure.pdf>.
- Reed, John. "Super Tucano Wins USAF's Light Attack Contest." *Defense Technology*. December 31, 2011. <http://defensetech.org/2011/12/31/embraer-wins-usafs-light-attack-contest/>.
- Russell, James A. "Irregular Warfare and Future War: Strategy and Defense Planning." *Strategic Insights*, 10 (2011): 92–98.

- Savage, Tom and Andrew Davies. "Delivering the Goods: The ADF's Future Battlefield Airlifter." *Australian Strategic Policy Institute*. March 2012, http://www.aspi.org.au/publications/publication_details.aspx?ContentID=333&pubtype=-1.
- Schanz, Marc. "The SOF Makeover." *Air Force Magazine*, Vol. 93, No. 6, June 2010. <http://www.airforcemagazine.com/MagazineArchive/Pages/2010/June%202010/0610SOF.aspx>.
- Shalal-Esa, Andrea. "U.S. Air Force Says it Briefed Afghan Plane Bidders." *Reuters*. June 13, 2012. <http://www.reuters.com/article/2012/06/14/us-afghanistan-planes-idUSBRE85D01S20120614>.
- Smith, Rupert. *The Utility of Force*. New York: Alfred A Knopf, 2007.
- Torres-Laboy, David and Michael W. Pietrucha. *Air Combat Command White Paper: The Case for OA-X*. Washington, DC: ACC/A3D Joint Air Ground Combat Division, 2009.
- Tran, Pierre. "Libya Extends Rafale's Combat Experience." *Defense News*. June 13, 2011. <http://www.defensenews.com/article/20110613/DEFFEAT06/106130316/Libya-Extends-Rafale-s-Combat-Experience>.
- Trimble, Stephen. "Rivals Not Deterred by USAF Shift on Turboprop Fighters." *Flightglobal*. September 15, 2010. <http://www.flightglobal.com/news/articles/rivals-not-deterred-by-usaf-shift-on-turboprop-fighters-347341/>.
- United States Air Force Aeronautical Systems Center. *Capability Request for Information for Air Combat Command (ACC) Light Attack/Armed Reconnaissance (LAAR)*. Air Force Materiel Command. 2010.
- United States Air Force Special Operations Command. *AC-XX Analysis of Alternatives*. June 2, 2008.
- . *Capability Production Document for Light Twin-Engine Aircraft to Support Aviation Foreign Internal Defense*. November 2011.
- . *Dragon Spear CR-3 Configuration Brief*. March 15, 2011.
- United States Bureau of Land Management. *EADS CASA CN-235 Preliminary Aircraft Evaluation for SASEB*. 2003. <http://www.blm.gov/nifc/st/en/prog/fire/Aviation/Airops/aircraft.html>.
- United States Department of the Air Force. "AC-130W Stinger II Fact Sheet." September 24, 2012. <http://www.af.mil/information/factsheets/factsheet.asp?fsID=4887>.

- . *Air Force Doctrine Document 1: Air Force basic Doctrine, Organization, and Command*. November 2003.
- . *Air Force Doctrine Document 2–7: Special Operations*. December 16, 2005.
- . “U-28A Factsheet.” <http://www.af.mil/information/factsheets/factsheet.asp?id=19315>.
- . “Air Force Priorities for a New Strategy with Constrained Budgets.” February 2012. <http://www.af.mil/shared/media/document/AFD-120201-027.pdf>.
- . *Department of Defense Fiscal Year (FY) 2013 President’s Budget Submission PDF*. February 2012. <http://www.saffm.hq.af.mil/shared/media/document/AFD-120210-115.pdf>.
- . *Department of Defense Fiscal Year (FY) 2012 Budget Estimates PDF*. February 2011. <http://www.saffm.hq.af.mil/shared/media/document/AFD-110211-038.pdf>.
- . *USAF Force Structure Changes: Sustaining Readiness and Modernizing the Total Force*. February 2012.
- United States Department of Defense. “Defense Cost and Resource Center.” http://dcarc.pae.osd.mil/reference/osd_ces_index.aspx.
- . *Quadrennial Defense Review Report*. February 6, 2006.
- . *Quadrennial Defense Review Report*. February 2010. http://www.defense.gov/qdr/images/QDR_as_of_12Feb10_1000.pdf.
- . *Quadrennial Roles and Missions Report*. January 2009.
- . *Irregular Warfare: Countering Irregular Threats Joint Operating Concept Version 2.0*. Washington, DC: United States Department of Defense, 2010.
- . *Joint Publication: Department of Defense Dictionary of Military and Associated Terms*. July 15, 2012.
- United States Department of State. “Department of State Aircraft Stored at the 309th Aerospace Maintenance and Regeneration Group.” December 9, 2011.

- United States Department of Transportation. "Appendix A, Aircraft Information Fixed-Wing Aircraft." *FAA Air Traffic Organization Policy*, Order JO 7110.65U (February 9, 2012).
<http://www.faa.gov/documentLibrary/media/Notice/N7110.525.pdf>.
- . "Interim Procedures for A380 Proving and Promotional Flights." *FAA Air Traffic Organization Policy*, Order JO 7110.478 (October 1, 2007).
<http://www.faa.gov/documentLibrary/media/Notice/ND/N%20JO%207110.478.pdf>.
- United States Federal Aviation Administration. *Fact Sheet—NextGen Goal: Performance-Based Navigation*. April 24, 2009. http://www.faa.gov/news/fact_sheetsnews_story.cfm?newsid=8768.
- United States Government Accountability Office. "Defense Management: DoD Needs Better Information and Guidance to More Effectively Manage and Reduce Operating and Support Costs of Major Weapon Systems." July 2010. <http://www.gao.gov/new.items/d10717.pdf>.
- United States House of Representatives Committee of Science and Technology*, 2 (1984). (Statement of John Kern, Deputy Director of Flight Operations, Federal Aviation Administration).
<http://testimony.ost.dot.gov/test/pasttest/84test/kern1.PDF>.
- United States Joint Chiefs of Staff. *Joint Publication 1–02: Department of Defense Dictionary of Military and Associated Terms*.
http://www.dtic.mil/doctrine/new_pubs/jp1_02.pdf.
- . *Joint Publication 3–05: Special Operations*.
<http://www.fas.org/irp/doddir/dod/jp3-05.pdf>.
- . *Joint Publication 3–22: Foreign Internal Defense*
http://www.dtic.mil/doctrine/new_pubs/jp3_22.pdf.
- United States Marine Corp. *Harvest Hawk ISR/Weapons Mission Kit Brief*. Washington, DC: HQ, U.S. Marine Corp, 2010.
- United States Office of the Secretary of Defense. *Air Force Programs: C-27J*.
<http://www.dote.osd.mil/pub/reports/FY2011/pdf/af/2011c27j.pdf>.
- United States Special Operations Command. *Fact Book 2012*.
<http://www.fas.org/irp/agency/dod/socom/factbook-2012.pdf>.
- . *Initial Capabilities Document for NATO Special Operations Air Warfare Center*. February 16, 2012.

———. “SOF Truths.” <http://www.socom.mil/default.aspx>

Viking Aircraft. *DHC-6/400 Twin Otter Performance at Maximum Weight*.
<http://weppi.gtk.fi/aerogeo/en/equipment/dhc6.pdf>.

———. “Twin Otter Series 400: Versatility That Works.” <http://www.vikingair.com/uploadedFiles/400S%20Multi-Page.pdf>.

Weisgerber, Marcus. “USAF: We Didn’t Inflate C-27J Cost.” *Defense News*.
March 19, 2012. <http://www.defensenews.com/article/20120319/DEFREG02/303190004/USAF-We-Didn-8217-t-Inflate-C-27J-Costs>

Winter, Walter. “A Medium-Sized Airlift Analysis for NATO SOF.” in *The NATO Special Operations Headquarters Air Warfare Center: A Smart Defense Approach*, edited by Arthur Davis and Keenan Yoho, 103–120. Monterey, CA: Naval Postgraduate School, 2012.

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